SENSORY RESEARCH ON GINSENG FOOD PRODUCTS

BY

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DISSERTATION

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ABSTRACT

Ginseng food products in the United States have mostly been restricted to beverages despite numerous pharmacological effects of ginseng and the growth of functional foods market. Few consumer sensory studies related to ginseng have been conducted in the United States. The overall objectives of this study were to: 1) probe U.S. consumers' insights of ginseng food products, 2) determine the sensory acceptance of ginseng food products, and 3) characterize the changes in the sensory properties of coffee and chocolate bitterness by the addition of ginseng extract. Three independent focus groups (n = 14) identified that panelists had little experience in consuming ginseng food products. Due to their unfamiliarity with ginseng, informative packaging including more health claims was recommended. The proposed ginseng food product types to be developed to target the U.S. market included ginseng chocolate and coffee. Addition of sweeteners and fruity and spicy flavors was recommended to reduce bitter and earthy flavors innate to ginseng. Conjoint analysis (n = 400) identified that consumers had a low initial interest in ginseng food products. "Sweetness" and "ginseng chocolate" elements drew consumers' interest, while "bitterness" and "earthy flavor" elements detracted from consumers' interest. Ginseng chocolate was identified again as a potential product for success in the United States. When commercial ginseng products were evaluated by a consumer panel (n = 126), Korean red ginseng candy with vitamin C and Korean red ginseng crunchy white chocolate were the most highly accepted. When ginseng was tested in model tea and chocolate systems, consumer acceptance increased with increasing content of sugar and honey in ginseng tea, whereas acceptance decreased with increasing content of ginseng extract in milk and dark chocolates. To assess the masking effect of peculiar ginseng tastes by other bitter compounds, a descriptive analysis (n = 12) including time-intensity ratings was conducted. The addition of ginseng extract intensified alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness of caffeine, cyclo (L-Pro-L-Val), and theobromine solutions as well as a model solution simulating milk chocolate bitterness. A model solution simulating dark chocolate bitterness showed a significant masking effect of ginseng bitterness. Findings from the study in its entirety suggest that dark chocolate would be a good base system to incorporate ginseng into, which will effectively mask peculiar ginseng tastes; consequently will have potential for success in the U.S. market. Additionally, it was concluded that more advertising, marketing, education, and informative packaging are necessary to increase U.S. consumers' familiarity with ginseng.

Key words: ginseng, focus group, conjoint analysis, descriptive analysis, consumer acceptance test, chocolate, bitterness

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CHAPTER 1. INTRODUCTION

1.1. BACKGROUND

The functional food market is growing rapidly, with the spread of scientifically proven health benefits of functional ingredients (Goldberg 1999; Hardy 2000). Functional foods are defined as “those foods in which the concentrations of one or more ingredients have been manipulated or modified to enhance their contribution to a healthful diet” by the Institute of Medicine of the U.S. National Academy of Sciences in 1994 (Katan and Roos 2004). Internationally, total sales of functional foods were $75 billion in 2007 and are expected to increase to $109 billion by 2010 (Sloan 2008). In the United States, sales of functional foods reached $4.3 billion in 2004 and have been forecasted to grow by $8.4 billion by 2014 (Mintel 2009).

For more than 2000 years, ginseng has been recognized in Asian countries as a panacea that offers various pharmacological effects (Siegel 1979; Lim and others 2005). Pharmacological effects of ginseng include anti-carcinogenic (Yun and Choi 1995; Duda and others 1996), anti-diabetic (Attele and others 1999; Xie and others 2005), and anti-fatigue (Saito and others 1974) properties. More recently, ginseng has been used as a popular ingredient for dietary supplements in the United States. Total estimated sales of ginseng dietary supplements reached approximately $100 million, which made up approximately 2 % of the total herbal dietary supplement sales in 2007 (Mintel 2008). However, utilization of ginseng in food products has been largely limited to energy drinks and teas in the United States. On the other hand, in Asian countries ginseng has long been incorporated into various food products, such as jellies, chocolates, chewing gum, and cookies, as well as drinks (Yang 1996). According to previous research, 76 % of consumers tested in the United States strongly believe that eating in a healthy manner rather than using medications is a better way to manage illness (Hasler 2002; Siró and others 2008). Therefore, development of more functional food products containing ginseng may allow the consumers to improve or maintain their health without negative side effects, such as the risks associated with taking medications.

Previous ginseng research has been focused primarily on elucidating its pharmacological effects. Consumer market research on ginseng, as well as sensory research, has not been extensively conducted in the United States. Consequently, there is little scientific information demonstrating consumers' insights into ginseng and related food products, acceptance levels of ginseng food products, or expectations that consumers may have about new ginseng food products. Food market research is complete when sensory evaluation is associated with it (Resurreccion 1998). Therefore, market research and sensory research on ginseng for U.S. consumers are prerequisites for the development of new ginseng food products which may be successful in the U.S. market.

The limited utilization of ginseng in food products could be attributed to the objectionable tastes of ginseng—in particular, its strong, bitter taste. In general, bitterness can present a problem for food manufacturers as well as consumers. Thus, food additives, including sweeteners, flavoring agents, and receptor blockers of bitter tastes, have been used to mask bitter tastes in certain foods (Drewnowski and Gomez-Carneros 2000; Ley 2008). However, these additives might generate consumer concerns about food safety risks and high calorie content (Wilcock and others 2004). On the other hand, coffee and chocolate are bitter foods widely consumed by people in spite of their strong, bitter tastes (Bruinsma and Taren 1999; Ley 2008). Therefore, incorporation of another bitter taste—which would be a more familiar type of bitterness—into ginseng food products may have an effect on making the peculiar bitter taste in such products more acceptable to consumers' palates.

1.2. HYPOTHESES OF RESEARCH

This research was designed to discover consumers' opinions about ginseng and related food products, and to examine sensory characteristics about ginseng and related food products. The main hypothesis is that peculiar bitter tastes inherent in ginseng will be masked by more familiar bitter tastes accepted by U.S. consumers, such as bitterness found in coffee and chocolate.

The first project included in the present research centered on an inquiry about U.S. consumers' awareness of and expectations about ginseng and related food products. Familiarity with functional foods is one of the key factors for consumers with regard to their likelihood of purchasing such products (Urala and Lahteenmaki 2003). However, ginseng may be unfamiliar to U.S. consumers because utilization of ginseng in foods and dietary supplements has been recently introduced in the United States, compared to the utilization in Asian countries. Therefore, the first hypotheses of this research were that: 1) U.S. consumers have limited knowledge of ginseng and related food products and 2) consumers will like ginseng product(s) if these are more similar to product types with which they may already be familiar.

The next questions concerned which ginseng food product(s) would have the potential for success in the marketplace, and what factors would influence consumers' intent to purchase ginseng food products. The first project qualitatively identified consumers' expectations of new ginseng food products, as well as the factors involved with consumers' intent to purchase ginseng food products. Thus, the second project was conducted in order to statistically validate the findings from the first project. On the basis of the findings from the first project, it has been hypothesized that ginseng food product concepts including ingredients that can modify intrinsic tastes of ginseng will drive consumers' interest.

The following inquiries included which commercial Korean red ginseng food product(s) would be highly acceptable to consumers in terms of sensory attributes, and how the content of sweeteners and ginseng extracts in ginseng food products would influence consumer sensory acceptance. The first project demonstrated that Korean red ginseng food products predominant in sweet and fruity flavors would be more acceptable to U.S. consumers than the ginseng food product having bitter and earthy flavors. In addition, findings from the second project proposed that sweet ginseng products and ginseng chocolates would drive the interest of most consumers. Therefore, a third project was launched with two accompanying assumptions; 1) ginseng food products that possess sweet and fruity flavors will be more acceptable to U.S. consumers and 2) consumer acceptance levels will increase with particular levels or types of sweetener added to ginseng food products, and will decrease with the amount of ginseng extract found in these products.

The last question to be answered was whether the bitter taste of ginseng, which is an unfamiliar sensation for most U.S. consumers, could be modified to provide a type of bitter taste that would be more familiar to the consumers, such as that found in coffee or in certain chocolates. Coffee and chocolate are among the bitter-tasting foods generally accepted by people despite their strong, bitter tastes (Bruinsma and Taren 1999; Ley 2008). The hypotheses of this project were that: 1) sensory profiles of ginseng will be different from those of bitter compounds found in coffee and chocolate, and 2) the peculiar taste of ginseng will be masked by the bitter, but familiar, tastes of coffee and chocolate.

1.3. SIGNIFICANCE OF THE RESEARCH

The findings from the present research will provide consumer insights of ginseng food products, which will help food-marketing experts plan marketing strategies, including advertisements and effective packaging of ginseng food products. Moreover, these findings will present the needs to educate the public about ginseng functional foods and will recommend establishing the regulations of labels on the package of ginseng food products. Results from this research propose factors that consumers expect to find in ginseng food products, as well as ginseng food product concepts that drive consumers' interests. These will help food manufacturers develop ginseng food products as well as general functional food products, which will ensure their success in the U.S. market. Moreover, findings from consumer acceptance tests would be beneficial for food manufacturers in predicting and developing ginseng food products type(s) whose sensory properties would most likely prove acceptable to U.S. consumers. Finally, this research suggests that certain types of bitter foods would be more acceptable as base products in which peculiar ginseng tastes are masked without the addition of sweeteners and flavoring agents.

1.4. OVERVIEW AND OBJECTIVES OF THE RESEARCH

The overall objectives of this study were to: 1) probe U.S. consumers' insights into ginseng food products, 2) determine the sensory acceptance levels of ginseng food products, and 3) characterize changes in sensory properties of coffee and chocolate bitterness by the addition of ginseng extract.

Chapter 2 of this dissertation discusses the literature on ginseng and its pharmacological effects as well as bioactive compounds found in ginseng. Sensory research recently conducted on ginseng and related food products was included in this chapter. Moreover, the chapter illustrates bitter foods and compounds responsible for bitterness in the foods, as concentrating on coffee and chocolate.

In chapter 3, U.S. consumers' attitudes about ginseng food products are assessed through focus groups. Consumers' expectations about ginseng food products, as well as their evaluation of the packaging of commercial ginseng products, are discussed in this chapter. The objectives of this study, which are included in chapter 3, are to: 1) evaluate consumers' awareness of and interest in ginseng food products, and 2) define consumers' expectations toward new ginseng food products through focus groups, as conducted in the United States.

Chapter 4 explains concepts of various ginseng food products that may have the potential for success in the U.S. market. The concept elements of ginseng food products that may attract consumers' interest are also demonstrated. The objectives of the research, which are covered in chapter 4 are to: 1) ascertain ginseng food product(s) that will possess potential for success in the U.S. market and 2) classify consumers based on the pattern of their responses to concept elements by using conjoint analysis.

In chapter 5 of this dissertation, consumer acceptance of various ginseng food products is examined. The objectives of the study included in this chapter are to: 1) determine the sensory acceptance levels of commercial Korean red ginseng products and 2) examine changes in sensory acceptance levels by the addition of sweeteners to ginseng tea and ginseng extract to chocolate systems.

Chapter 6 examines sensory characteristics of ginseng extract and major bitter compounds found in coffee and chocolate. The objectives of the study, which are comprised in chapter 6, are to: 1) characterize sensory properties of ginseng extract, caffeine, cyclo (L-Pro-L-Val), theobromine, and two model solutions, which simulate chocolate bitterness and 2) examine the modification in the sensory profile of caffeine, cyclo (L-Pro-L-Val), theobromine, and the model solutions by the addition of ginseng extract, with descriptive analysis including time-intensity ratings.

Chapter 7 summarizes the four research chapters. This chapter briefly describes research procedure, outcomes, and discussion of the individual studies. Suggestions for future studies are also included in this chapter.

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CHAPTER 2. LITERATURE REVIEW

2.1. GINSENG

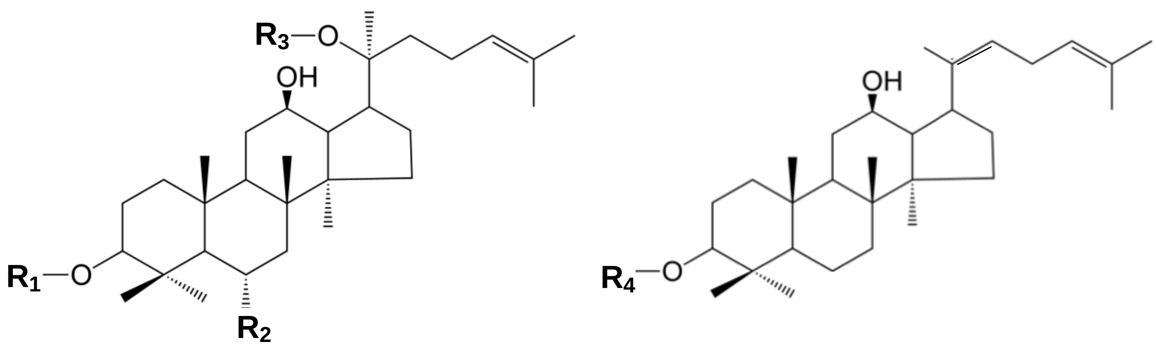
Ginseng has been used as a traditional medicine in Asian countries for more than 2000 years. In North America, ginseng has been harvested from wild populations for nearly 300 years, and has been commercially cultivated since the 19th century (Lim and others 2005). Ginseng has been one of the top-10-selling herbal dietary supplements in the United States, and total estimated sales of ginseng dietary supplements reached approximately $100 million in 2007 (Mintel 2008).

The term ginseng is derived from Chinese “jen-shen”, which means “images of man”, and refers to members of the genera *Panax* in the family Araliaceae, which means panacea (Hostettmann and Marston 1995; O'Hara and others 1998). A ginseng plant consists of a root, flowers, and elongated leaves. The roots are the most commercially important part, which vary from 2 to 10 cm in length and from 1 to 2 cm in diameter (Mazza and Oomah 2000). Among several different varieties, Asian ginseng (*Panax ginseng* C.A. Meyer) and American ginseng (*Panax quinquefolius* L.) have been most widely used in foods and medicines. Ginseng has been known to have numerous pharmacological effects, which are attributed to the bioactive compounds included in ginseng species, such as ginsenosides (Chen and Staba 1980), polyacetylenes (Beveridge and others 2002), phytosterols (Christensen and others 2006), and polysaccharides (Attele and others 1999).

2.1.1. Ginsenosides and Their Pharmacological Effects

Ginsenosides are triterpenoid saponin glycosides unique to the genera *Panax*. They have been also named as ginsenoside saponins or dammarane derivatives under previous classifications (Attele and others 1999; Schlag and McIntosh 2006). Approximately 30 ginsenosides have been found in ginseng roots and are usually classified into two groups according to their aglycones in the saponins. The glycosides of 20(S)-protopanaxadiol include Rb_1, Rb_2, Rc, Rd, Rg_3 and Rh_2, and those of 20(S)-protopanaxatriol comprise Re, Rf, Rg_1, Rg_2, and Rh_1 (Schlag and McIntosh 2006).

Ginsenosides Rb_1, Rb_2, Rc, Rd, and Re are the major constituents of ginseng roots, and accounted for 90 % of the total content (Wang and others 1999; Li and others 2000). The total ginsenoside contents vary depending on the varieties (van Breemen and others 1995), age, and part of the ginseng plant (Court and others 1996; Lim and others 2005), soil fertility (Li and Mazza 1999), and location (Assinewe and others 2003; Lim and others 2005). American ginseng contains 3 to 11 % of ginsenosides in the roots, 2 to 13 % of ginsenosides in the leaves, and about 10 % of ginsenosides in the berries (Li and others 1996; Wang and others 2006).



Ginsenosides	R_1	R_2	R_3	R_4
Rb_1	$-Glc_2-Glc^{§}$	-H	$-Glc_6-Glc$	-
Rb_2	$-Glc_2-Glc$	-H	$-Glc_6$-Ara(pyr)	-
Rc	$-Glc_2-Glc$	-H	$-Glc_6$-Ara(fur)	-
Rd	$-Glc_2-Glc$	-H	-Glc	-
Re	-H	$-Glc_2-Rha$	-Glc	-
Rf	-H	$-Glc_2-Glc$	-H	-
Rg_1	-H	-Glc	-Glc	-
Rg_2	-Hc	$-Glc_2-Rha$	-H	-
Rg_3	$-Glc_2-Glc$	-H	-H	-
Rg_5	-	-	-	$-Glc_2-Glc$
Rh_1	-H	-O-Glc	$-Glc_6-Glc$	-
Rh_2	-Glc	-H	$-Glc_6-Glc$	-
Rh_3	-	-	-	-Glc

§ Numbers indicate the carbon in the glucose ring that links the two carbohydrates. Glc, glucopyranoside; Ara(pyr), arabinopyranoside; Ara(fur), arabinofuranose; Rha, rhamnophyranoside. The picture and the table were cited from Nah and others (2007).

Figure 2.1. Chemical structure of major types of ginsenosides

Ginsenosides have been considered as the most important group of bioactive compounds in ginseng, which are associated with numerous health benefits. Ginsenoside Rb_1 has effective anti-inflammatory and vasodilating effects (Xu and others 2003). Ginsenoside Rg_1 increased immune responses and relieved fatigue (Kenarova and others 1990; Xu and others 2003). Moreover, ginsenosides Rb_1 and Rg_1 had positive effects on prevention of memory deficits and enhancement of nerve growth (Benishin and others 1991; Yamaguchi and others 1995; Salim and others 1997). Ginsenoside Rc effectively inhibited growth of breast cancer cells (Murphy and others 2001) and ginsenoside Rh_2 effectively suppressed growth of cancer cells, including breast cancer, ovarian cancer, and prostate cancer (Tode and others 1993; Murphy and others 2001; Kim and others 2004). Ginsenoside Rg_3 inhibited the proliferation of prostate cancer cells and ginsenoside Re displayed anti-diabetic activities (Kim and others 2004; Xie and others 2005).

2.1.2. Asian Ginseng and American Ginseng

Asian ginseng (*Panax ginseng* C.A. Meyer) is grown throughout Korea, China, and Russia, and American ginseng (*Panax quinquefolius* L.) is distributed in North America from southern Quebec to Minnesota and from south Oklahoma to Georgia (Mazza and Oomah 2000; Assinewe and others 2003). In the United States, Wisconsin is the largest producer of American ginseng (Kitts and Hu 2007). The two varieties of ginseng are slightly different in the composition of bioactive compounds and subsequent pharmacological effects (Hardy 2000). Ginsenosides Rb_1, Rb_2, Rc, Rd, Re and Rg_1 are found both in Asian ginseng and American ginseng. However, American ginseng has little or no ginsenoside Rf and has a lower ratio of ginsenoside Rg_1 to Rb_1 than Asian ginseng (van Breemen and others 1995; Harkey and others 2001). Therefore, the ratio of Rg_1 to Rb_1 has been used as a quantitative method to distinguish the two varieties of ginseng (Corthout and others 1999). Moreover, the ratio of Rg_1 to Rb_1 has been associated with different pharmacological effects between American ginseng and Asian ginseng. A pharmacological effect of ginsenoside Rg_1 has been identified as a weak stimulant of the central nervous system, while ginsenoside Rb_1 acts to depress the central nervous system. Therefore, American ginseng has been known for having a less stimulating effect on the human body than Asian ginseng (Harkey and others 2001).

2.1.3. Red Ginseng

Red ginseng has been widely used in various food products in South Korea. White ginseng is generally produced by peeling raw ginseng roots and air-drying them. Meanwhile, red ginseng roots are processed by steaming raw ginseng roots at 98 to 100 ℃ for 2-3 hrs and then drying them (Kim and others 2000; Kim and others 2002; Angelova and others 2008). Red ginseng is characterized by its reddish brown color and glossy surface, which is due to a non-enzymatic browning reaction that takes place during heat processing. Generally, 4- to 6-year-old ginseng roots are used for red ginseng processing. In particular, six-year-old ginseng roots are known for having the highest quality for both pharmacological effects and exterior shape (Koo and others 2005). Differences in profile and total content of ginsenosides were found between red Asian ginseng and red American ginseng. Red American ginseng was identified as being higher in total ginsenoside content when compared to red Asian ginseng. Red Asian ginseng contained ginsenosides in the order of $Rb_1 > Rg_1 > Re > Rc > Rb_2 > Rf > Rg_2 > Rd$. Meanwhile, red American ginseng had ginsenosides in the order of $Rb_1 > Re > Rg_1 > Rd > Rc > Rb_2 > Rg_2$ and did not contain ginsenoside Rf (Chung and Lee 2007). Red ginseng has been reported to have more enhanced pharmacological effects and milder ginseng flavors than white ginseng, owing to changes in its chemical constituents during heat processing (Do and others 1993; Kim and others 2000). Ginsenosides Rg_3, Rg_5, Rg_6, Rh_2, Rh_3, Rh_4, Rs_3 and F_4 have been found in red ginseng—constituents that do not usually exist in raw ginseng (Ryu and others 1997; Kim and others 2000).

2.1.4. Sensory Research on Ginseng and Related Food Products

Little has been researched about the sensory properties of ginseng and related food products in Western countries. Most research related to ginseng has focused on its pharmacological effects. A majority of sensory studies related to ginseng were conducted in Asian countries—in particular, in South Korea.

Ginseng products have been reported to have earthy, woody, molasses, astringent, bitter, and sweet flavors (Kim and Sung 1985; Park and others 1999). Ginsenosides have been considered as a major contributor to the peculiar bitter tastes of ginseng because most saponins have been known to elicit bitterness. However, there has been little research elucidating the relationship between ginsenosides and their sensory properties. With respect to aroma in ginseng, methoxypyrazine derivatives and some acids have been identified as contributing to earthy, floral, herbal, and moldy aroma in fresh or white ginseng (Iwabuchi and others 1984; El-Aty and others 2008). Fresh ginseng roots have been reported to have strong fresh, earthy, herbal, and floral flavors, while red ginseng roots were characterized as strong fragrant, sweet, and roast flavors. The fragrant and sweet flavors have been attributed to production of 3-hydroxy-2-methyl-pyran-4-one during heat processing (Lee and others 2005).

Sensory studies on ginseng have been mainly conducted as a part to examine changes in quality of ginseng roots during preservation with various treatments. Kwon and others (2000) and Jin and others (2007) found that gamma-irradiation and electron beam irradiation did not significantly influence overall flavors, appearance, and color of white ginseng roots, while phosphine fumigation produced undesirable flavors in the ginseng roots. Further research on the changes in sensory characteristics of foods with the addition of ginseng ingredients includes studies on tofu with ginseng extract (Kim and others 1996), pumpkin cookies with ginseng extract (Song and others 2007), ginseng-whey beverages (Kee and Hong 1993), pork cutlet containing ginseng saponins (Cho and others 2003), ginseng-yogurt (Lee and Paek 2003), kiwi-ginseng beverages (Park and others 1994), and alcohol beverages containing ginseng (Yoon and others 2007). However, these studies were conducted by using a simplified descriptive analysis, which did not include sensory descriptive term generation and refinement procedure through panel discussion or utilized untrained panel. Furthermore, the studies did not include consumer acceptance test; thus, they were not able to provide information on the acceptability of the new ginseng food products.

2.2. BITTERNESS IN FOODS

Bitter tastes are commonly found in vegetables, fruits, and tree nuts, including broccoli, cauliflower, soybeans, lemon, grapefruit, green tea, red wine, coffee beans, cocoa beans, almonds, and walnuts (Drewnowski and Gomez-Carneros 2000). Diverse compounds elicit bitterness: these are categorized into amines, amino acids, alkaloids, flavonoids, terpenoids, and inorganic salts (Meyerhof and others 2009). Bitter tastes are generally recognized as an undesirable sensation for most people (Drewnowski and Gomez-Carneros 2000). However, a segment of the population is fond of strong bitter tastes for certain foods and beverages, such as black coffee, dark chocolate, green tea, beer, red wine, and grapefruit (Ley 2008). Acceptance levels of bitterness vary depending on genetic differences, dietary experience, and age (Schiffman and others 1994; Drewnowski 1997; Kim and Drayna 2005; Reed and others 2006).

2.2.1. Mechanism of the Taste Perception of Bitterness

The mechanism of bitterness perception has not been fully understood to date. Previous studies have found that there might be several different receptors and transduction mechanisms for the perception of bitterness, and more than one mechanism was involved in the perception of bitterness (Spielman and others 1992). Much biochemical and physiological evidence has suggested that bitter transduction in taste receptor cells is mediated by G-proteins and G-protein-coupled receptors (Chandrashekar and others 2000). Bitter molecules bind to a G-protein-coupled receptor type T2R on the apical membrane of the taste receptor cells located in the taste buds. One particular bitter molecule can bind to several T2R subtypes with distinct affinity. Roughly 25 different T2R are identified in humans (Brockhoff and others 2007; Ley 2008). Currently, the most accepted theories include a pathway involving, 1) G-protein activating enzyme phosphodiesterase (PDE) and 2) G-protein stimulating enzyme-activated inositol trisphosphate (IP_3) (Drewnowski 2001). In the former pathway, bitter compounds activate T2R and subsequently α-gustducin, which is one of the gustducin heterotrimers. The activated α-gustducin stimulates PDE to decrease intracellular cAMP, so as to elevate intracellular Ca^{2+}. In the latter pathway, βγ-subunits of gustducin are released from activated α-gustducin and activate phospholipase $C\beta_2$ to generate IP_3 leading to release of

Ca^{2+} from internal stores (Drewnowski 2001; Margolskee 2002). However, it has been not known whether the increase in Ca^{2+} then serves as the primary signal responsible for the bitter sensation (Fain 2003).

Previous studies identified that bitterness of some compounds involved one or more mechanisms (Spielman and others 1992). Quinine has been identified as being involved with the G-protein/PDE pathway. However, the transduction mechanism of quinine has also been related to the G-protein/IP_3 pathway. Additionally, denatonium benzoate has been involved both with the G-protein/PDE pathway and the G-protein/IP_3 pathway. Naringin and sucrose octa-acetate increased Ca^{2+} via the pathway of G-protein/IP_3. Limonin has been associated with the G-protein/PDE pathway. However, caffeine has been reported to permeate taste cells and directly increase Ca^{2+} level by activating Ca^{2+} channels (Herness and Gilbertson 1999; Cubero-Castillo and Noble 2001; Lindemann 2001).

2.2.2. Coffee, Milk Chocolate, and Dark Chocolate

Coffee and chocolates are widely popular in the United States, although these foods elicit strong bitter tastes. Total sales of coffee reached \$6.7 billion in 2008 and were forecasted to grow by about \$8 billion by 2014 in the United States (Mintel 2009a). The chocolate market is larger than the market for coffee. Total sales of chocolate confectionery were \$16.3 billion in 2007 and are expected to reach \$18.3 billion by 2013 in the United States (Mintel 2009b). In particular, 67 % of consumers purchased chocolates simply because they had a chocolate craving, and 49 % of consumers purchased for no particular reason (Mintel 2009b). Furthermore, coffee and chocolates have been reported to rank the first and the second in specialty foods that consumers purchased in 2009 (Mintel 2009c).

Coffee

Two species of coffee beans that are economically important include *Arabica*, which forms 90 % of the world's coffee production, and *Canephora* variant *Robusta*, which makes up approximately 9 % of the world's coffee production (Briandet and others 1996). Various different types of coffee products are present in the market, such as roasted whole coffee beans, ground-roasted coffee, and instant coffee. Although the relationship of coffee consumption and human health is still being debated, recent studies have reported that coffee consumption has been associated with reductions in the risk of several chronic diseases such as type-2 diabetes mellitus, Parkinson's disease, and liver disease. On the other hand, coffee consumption has been related to an increase in blood pressure and plasma homocysteine, which are risk factors for cardiovascular diseases (Higdon and Frei 2006).

Coffee is a major source of caffeine and chlorogenic acids. Caffeine has been known to stimulate the central nervous system, elevate blood pressure, alleviate migraine headaches, increase metabolic rate, reduce fatigue, and cause a diuretic effect (Carrillo and Benitez 2000; Winston and others 2005). Chlorogenic acids—including 5-*O*-caffeoylquinic acid—have been reported to exhibit weak antioxidant activity. Cafestol and kahweol, which are diterpenes found in coffee oil, have been believed to increase serum total and low-density lipoprotein (LDL) cholesterol concentrations (Higdon and Frei 2006). A raw (green) coffee bean is almost odorless and is characterized as being grassy or earthy, and having a hay-like aroma. During the roasting process, at approximately 170 °C, various volatile compounds of coffee are produced through physical and chemical reactions of polysaccharides, proteins, chlorogenic acids, and trigonelline contained in the beans (Dorfner and others 2004). Potent aroma compounds in roasted coffee beans include acetaldehyde, methylpropanal, 2- and 3-methylbutanal, 2,3-butanedione, 2,3-pentanedione, 2-furfurylthiol, 2-ethyl-3,5-imethylpyrazine, and 2,3-diethyl-5-methylpyrazine (Florian and Werner 2001).

Chocolates

Chocolates are produced with cacao beans—the seeds of the *Theobroma cacao* tree. The processing of cacao beans into chocolate includes fermentation, drying, and roasting of the harvest cacao beans. The de-hulled roasted cacao beans, which are called cocoa nibs, are milled to obtain cocoa liquor (Borchers and others 2000). Dark chocolate is a sweetened chocolate including no or small amounts of milk solids. Dark chocolate is also known as sweet chocolate or bittersweet chocolate. Milk chocolate is a sweetened chocolate that includes milk solids (Gu and others 2006). In general, milk chocolate contains 8.5 to 40 % of cocoa nibs, and dark chocolate includes 35 to 70 % of cocoa nibs (Beckett 1999). In the United States, milk chocolate is required to contain not less than 10 % by weight of chocolate liquor and not less than 12 % of total milk solids (FDA 2009a). Sweet chocolate and bittersweet chocolate—not specified as "dark" chocolate—should include not less than 15 % and not less than 35 % of chocolate liquor, respectively (FDA 2009b). Meanwhile, the European Union dictates that milk chocolate should contain not less than 25 % of total dry cocoa solids, and chocolate not less than 35 % of total dry cocoa solids, although the type of chocolate was not specified as sweet, bittersweet, or dark chocolate (EPC 2000).

Dark chocolate, which contains a higher percentage of cocoa bean liquor than milk chocolate, has been known to contain greater amounts of flavonoids, and, subsequently, has more antioxidative effects. Polyphenol-rich dark chocolate has been reported to enhance insulin sensitivity and decrease blood pressure (Grassi and others 2005). Catechin, epicatechin, and procyanidins, which are flavonoids most commonly found in chocolates, have been known to act as antioxidants in the human body. Procyanidins suppress oxidation of LDL and the development of atherosclerosis, and inhibit growth of human breast cancer cells (Steinberg and others 2003; Gu and others 2006). Epicatechin increases plasma antioxidant capacity and decreases plasma lipid oxidation products (Steinberg and others 2003).

2.2.3. Bitter Compounds Found in Coffee and Chocolate

Bitterness in coffee and chocolate is believed to be associated with various compounds such as xanthines, diketopiperazines, and flavonoids.

Caffeine

Caffeine, 1,3,7-trimethylxanthine, is a methyl xanthine derivative found in coffee and chocolate products. Caffeine bitterness has been described as a unique bitter taste or a bitter taste being unable to be replicated by using any other bitter compounds (Allison and Chambers IV

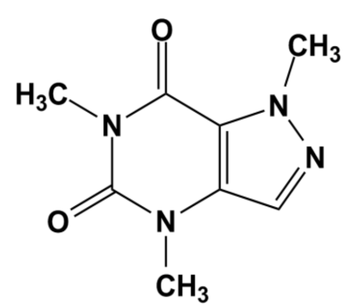


Figure 2.2. Chemical structure of caffeine

2000). Caffeine is found at levels of 0.02 to 0.09 % in brewed coffee and 0.03 to 0.07 % in instant coffee (Barone and Roberts 1996). Caffeine is also present at levels of 0.0013 to 0.35 % in liquid or powder cocoa (Zoumas and others 1980; Craig and Nguyen 1984; Serra Bonvehi and Ventura Coll 2000), 0.005 to 0.072 % in milk chocolate (Zoumas and others 1980; Craig and Nguyen 1984), 0.017 to 0.119 % in dark chocolate (Craig and Nguyen 1984; De Camargo and Toledo 1999), and 0.101 % in roasted cocoa nibs (Stark and Hofmann 2005). Threshold values of caffeine range from 0.014 to 0.035 g in 100 mL of water (Robinson and others 2004; Stark and others 2006).

Theobromine

Theobromine, which is 3,7-dimethylxanthine, is the most predominant alkaloid in cocoa, and its concentration depends on the origin and ripeness of the cocoa, as well as the fermentation process (Serra Bonvehi and Ventura Coll 2000). Theobromine has been known for its metallic bitterness, which is relatively stable but not immediately perceptible and has been recognized solely by the rear portion of the tongue (Pickenhagen and others 1975). Theobromine is found at levels of 0.27 to 2.6 % in dried cocoa beverage powder (Zoumas and others 1980; Craig and Nguyen 1984; Serra Bonvehi and Ventura Coll 2000), 0.135 to 0.188 % in milk chocolate, 0.359 to 0.628 % in dark chocolate (Zoumas and others 1980; Matissek 1997), and 1.145 % in roasted cocoa nibs (Stark and Hofmann 2005). Threshold values of theobromine have been reported as 0.001 to 0.014 g in 100 mL of water (Ney 1986; Stark and Hofmann 2005).

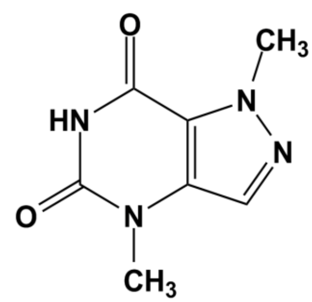


Figure 2.3. Chemical structure of theobromine

Diketopiperazines

Diketopiperazines (DKPs), which are cyclic dipeptides produced during the roasting of cocoa beans, have been identified as another contributor to the bitterness of chocolate (Pickenhagen and others 1975; Serra Bonvehi and Ventura Coll 2000; Stark and Hofmann 2005). Rizzi (1989) proposed that diketopiperazines were directly formed from non-bitter linear peptides or proteins, rather than cyclization from free amino acids. Pickenhagen and others (1975) found that the DKPs containing phenylalanine had the closest resemblance to the bitterness of chocolate, which was felt throughout the entire mouth and was rapidly detected, yet disappeared quickly. They also found that the diketopiperazines had a synergistic effect on the intensity of bitterness when presented with theobromine. Serra Bonvehi and Ventura Coll (2000) found that cyclo (-Pro-Gly) and cyclo (-Ala-Gly) were more related to a metallic bitter taste than theobromine. Meanwhile, a more recent study identified cyclo (L-Pro-L-Val) as the most important DKP contributing to the bitterness of roasted cocoa nibs (Stark and Hofmann 2005; Stark and others 2006). The authors found that cyclo (L-Pro-L-Val) was most responsible for bitter taste among 25 diketopiperazines, including cyclo (-Pro-Gly), cyclo (-Ala-Gly), and another diketopiperazines containing phenylalanine when the threshold values and the amounts of diketopiperazines found in roasted cocoa nibs were considered. Cyclo (L-Pro-L-Val) was also identified as influencing bitter tastes as much as caffeine in roasted cocoa. However, the research related to DKPs, including which DKPs are more responsible for the bitterness of chocolate, has not been concluded. Cyclo (L-Pro-L-Val) is found at 0.174 g in 100 g of roasted cocoa nibs. Reported threshold values of cyclo (L-Pro-L-Val) have varied from 0.025 to 0.050 g in 100 mL of water for bitter taste and from 0.001 to 0.020 g in 100 mL of water for metallic, lingering, and salty tastes, as well as mouth-feel (Gautschi and Schmid 1997; Stark and Hofmann 2005; Chen and others 2009).

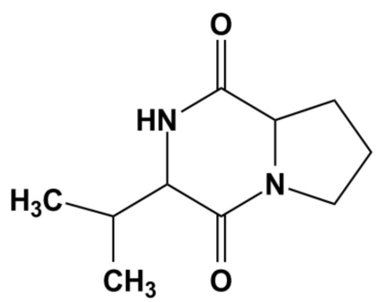


Figure 2.4. Chemical structure of cyclo (L-Pro-L-Val)

Catechin and Epicatechin

(+)-Catechin and (-)-epicatechin, belonging to the class of flavonoids, are commonly found in chocolates. Catechin was found to be contained at levels of 0.005 to 0.072 % in milk chocolate, 0.011 to 0.066 % in dark chocolate, and 0.069 % in roasted cocoa nibs (Arts and others 1999; Tokusoglu and Unal 2002; Stark and Hofmann 2005;

Gu and others 2006). Epicatechin was found at levels ranging from 0.011 to 0.839 % in milk chocolate and from 0.052 to 0.302 % in dark chocolate (Tokusoglu and Unal 2002; Gu and others 2006). Roasted cocoa nibs contained 0.25 % of epicatehin (Stark and Hofmann 2005). Catechin in cocoa has been characterized as having a bitter taste with a sweet aftertaste, or a mixed taste of bitterness and astringency (Drewnowski and Gomez-Carneros 2000; Stark and Hofmann 2005). Thorngate and Noble (1995) found that epicatechin was more bitter than catechin and the bitterness lasted longer than catechin at the same concentrations. These authors reported that astringency was also rated slightly higher for epicatechin than catechin.

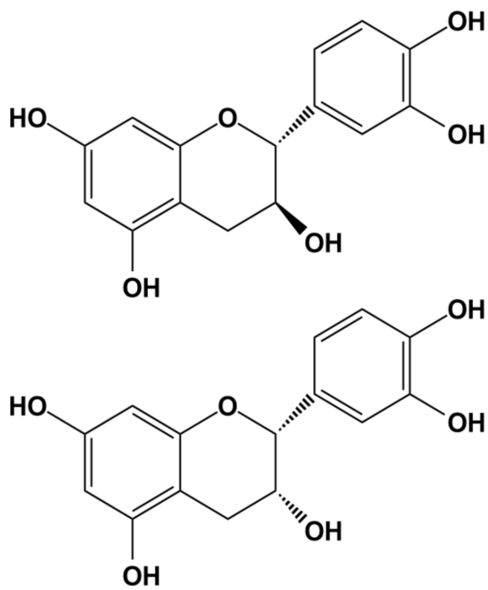


Figure 2.5. Chemical structure of (+)-catechin (top) and (-)-epicatechin (bottom)

2.3. CONCLUDING REMARKS

Consumer interest in functional food products is increasing with their various health benefits. Sensory acceptance is a key factor to consumers in purchasing functional food products as important as their health benefits. However, previous ginseng research has mainly focused on investigating pharmacological effects of ginseng rather than evaluating consumer acceptance or sensory properties of ginseng food products. In particular, previous ginseng studies have not been extensively conducted toward U.S. consumers, who are less familiar with ginseng than Asian consumers. Moreover, utilization of ginseng in food products is limited to a few food products including energy drinks and teas in the United States. Peculiar tastes in ginseng—in particular, a strong bitter taste, have been considered as a main problem lowering consumer acceptance. However, there have been few studies characterizing ginseng tastes and relating the sensory properties of ginseng to consumer acceptance. In general, a taste of bitterness is considered as an undesirable sensation. However, a large segment of people enjoy consuming chocolate and coffee, which elicit bitter tastes. Therefore, upcoming ginseng research will need to include characterizing bitterness of ginseng, and comparing the sensory profiles with other bitter foods, which are more accepted by the consumers, by employing a descriptive analysis. Furthermore, future ginseng studies shall be conducted in the area of consumer testing on pre-existing ginseng food products and newly-developed ginseng food products. This can be conducted by using consumer interviews such as focus groups and a conjoint analysis, which is a research technique for predicting consumer needs. Such sensory-related and consumer-oriented ginseng research will promote the development of new ginseng foods which will satisfy the consumers in both health benefits and sensory properties.

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CHAPTER 3. UNDERSTANDING CONSUMER ATTITUDES AND EXPECTATIONS TOWARD GINSENG FOOD PRODUCTS: A FOCUS GROUP STUDY

3.1. ABSTRACT

Ginseng is one of the most popular medicinal herbs due to its renowned health benefits, and has been used for over 2000 years in Asian countries. However, Western consumers are less familiar with ginseng food products than Asian consumers. The objectives of the study were to: 1) assess the U.S. consumers' awareness of and interest in ginseng food products, and 2) delineate expectations toward new ginseng food products through focus groups. Three independent focus groups (*n* = 14) were conducted. Panelists had little knowledge of ginseng and its health effects, and experienced limited types of ginseng food products, such as energy drinks and teas. The popularity of the product brand and packaging information were the main factors that would influence purchase intent of ginseng food products. More health claims about ginseng on the package were recommended to educate the prospective consumers. New ginseng food products proposed were cookies, snacks, cereals, energy bars, chocolates, and coffee. Addition of sweeteners and fruity and spicy flavors was recommended to reduce bitter, earthy, musty, and molasses flavors innate to ginseng. More advertising, marketing, and education deemed necessary to increase awareness of the health benefits of ginseng.

Key words: ginseng, ginseng food products, focus group, packaging

3.2. INTRODUCTION

Ginseng has been one of the top-10-selling herbs for dietary supplements in the United States since the statistics began being collected in 2003 (Mintel 2008). Total estimated sales of herbal dietary supplements reached approximately $4.8 billion, of which ginseng sales made up 2 % in 2007 (Mintel 2008). *Panax ginseng* C.A. Meyer, known as Asian ginseng, has been cultivated in China and Korea, and has been used as a traditional medicine for more than 2000 years (Shibata and others 1985). *Panax quinquefolius* L. has been produced in North America and is generally called American ginseng (Assinewe and others 2003). These two varieties of ginseng have commonly been used for dietary supplements and additives in healthy food products (Schlag and McIntosh 2006).

Ginseng has been reported to have positive health effects, including stimulatory and inhibitory effects on the central nervous system (Saito and others 1977), growth inhibitory effects against tumor cells (Yun and Choi 1995; Duda and others 1996), immunomodulatory effects (Kenarova and others 1990; Kim and others 1990), and anti-diabetic activities (Attele and others 1999; Xie and others 2005). Ginseng has been also known for improving impaired memory and learning (Salim and others 1997; Li and others 1999), preventing fatigue (Saito and others 1974), improving the recovery response from physical work or aerobic exercise performance (Engels and others 1996; Engels and Wirth 1997), and increasing the number of spermatozoa and their mobility in humans (Salvati and others 1996). Such pharmacological effects are attributed primarily to ginsenosides, which are unique to the genera *Panax* and are known as triterpenoid saponin glycosides (Schlag and McIntosh 2006).

The total ginsenoside content of a root varies between 0.7 and 20 % (Attele and others 1999; Corthout and others 1999), although the contents are dependent on the varieties (van Breemen and others 1995) and age (Court and others 1996; Lim and others 2005) of ginseng roots, soil fertility (Li and Mazza 1999), and location (Assinewe and others 2003; Lim and others 2005). More than 27 ginsenosides have been found in ginseng and usually classified into two groups, the glycosides of 20(S)-protopanaxadiol including Rb_1, Rb_2, Rc, Rd, Rg_3, and Rh_2, and those of 20(S)-protopanaxatriol comprising Re, Rf, Rg_1, Rg_2, and Rh_1 (Schlag and McIntosh 2006). Ginsenosides Rb_1, Rb_2, Rc, Rd, Re, and Rg_1 are found both in *Panax quinquefolius* and *Panax ginseng*. However, *Panax quinquefolius* has little or no ginsenoside Rf and has a lower ratio of ginsenoside Rg_1 to Rb_1 than *Panax ginseng* (van Breemen and others 1995; Harkey and others 2001).

Food packaging stimulates purchasing behavior because it is a medium of attention, information, quality, and aesthetics (Bech-Larsen 1996). The visual appearance of the packaging as well as the sensory appeal of a food product has a significant influence on consumer acceptability. Therefore, manufacturers should understand the packaging characteristics of a food product which drive consumer preference within the market segment of interest and apply this understanding to packaging (Murray and Delahunty 2000). In particular, nutritional and pharmacological information on packaging are needed for newly introduced functional food products because of limited consumer knowledge and awareness of the health benefits of the ingredients in such products (Menrad 2003).

The development and commerce of functional foods conformable with consumer acceptance is complex, expensive, and risky (van Kleef and others 2002; Siró and others 2008). Understanding consumer expectations of new functional foods is critical for development of market-oriented and consumer-led product because functional food opportunities are largely consumer-driven (Gilbert 1998; Verbeke 2005). A focus group is a qualitative research technique that is generally used in the early stages of product development and marketing research to discuss a set of new product concepts or identify the most important drivers of consumer choice for a particular product (Hayesl 1989; Langford and McDonagh 2003; Dransfield and others 2004; van Kleef and others 2005). A focus group consists of a trained moderator and panelists. The moderator follows a series of predetermined questions and makes sure that the discussion does not go off track (Lawless and Heymann 1997). The number of panelists in a focus group depends on the purpose of the focus group, ranging from 3 to 12 (Stewart and others 1994; Chalofsky 1999; Krueger and Casey 2000). The use of mini focus groups, consisting of 3 to 6 panelists in each group, has gained popularity in recent years due to the ease of recruiting panelists and the comfortable setting for sharing views (Krueger and Casey 2000). The main advantage of focus groups is that panelists are able to select the manner in which they respond or interact to, debate, or change their opinions about products during discussion with others (Dransfield and others 2004). Results obtained from focus groups can also be used to construct questionnaires for subsequent quantitative analysis (Brug and others 1995).

Previous ginseng research has mainly focused on its pharmacological effects. The number of ginseng food products available in the U.S. market is also very limited, thus unfamiliar to these consumers, although there has been growing interest in functional foods with bioactive ingredients. Consequently, consumer research on ginseng food products as well as sensory research has not been conducted in the United States. Thus, the objectives were to: 1) assess consumers' awareness of and interest in ginseng food products, and 2) delineate expectations toward new ginseng food products through focus groups conducted in the U.S. This study includes packaging and sensory evaluation of commercial ginseng food products.

3.3. MATERIALS AND METHODS

Commercial Ginseng Food Products Used in Focus Groups

Commercial ginseng food products were used for this study. For the packaging evaluation, three ginseng food products sold in the United States were purchased in local grocery stores (Urbana, IL, USA) and four Korean red ginseng food products, which are commercially sold in Korea, were obtained through the Korean Food Research Institute (KFRI, Sungnam, Korea). A list of the ginseng food products used in packaging evaluation is shown in Table 3.1. The products available in the United States include two teabag products and a beverage product, which were selected by a preliminary focus group as the best or worst packaging from among 33 commercial ginseng food products. The Korean red ginseng food products were chosen based on the packaging types that were quite different from the commercial products available in the U.S. grocery stores. The Korean red ginseng food products were presented with Korean to English translation to help panelists' understanding of the product name and ingredients.

Five commercial Korean red ginseng food products were also used for sensory evaluation in order to learn sensory terms that panelists describe about Korean red ginseng food products. A list of the products along with a brief description is shown in Table 3.2. For the sensory evaluation, all ginseng food products were taken out from individual packaging and were presented in 59-mL plastic cups (Solo Cup Co., Urbana, IL, USA) with lids and were labeled with 3-digit random codes. Korean red ginseng extract tea was prepared by dissolving 1 g of the extract into 180 mL of hot water and cooling at room temperature (~22 ℃) according to the directions on the package.

Subjects

A total of 14 panelists (5 males and 9 females, 19 to 29 years of age) participated in three focus groups, consisting of 3, 5, and 6 panelists. The focus group panels consisted of Caucasian (9), African-American (3), and Asian (2) subjects. All subjects were recruited through the use of an email list or flyers posted on campus at the University of Illinois at Urbana-Champaign. Only those panelists that had consumed ginseng food products more than once were selected to be on the panel, through the use of pre-screening questionnaire (Appendix A).

Focus Group Discussion Procedure

Panelists completed a consent form approved by the University of Illinois Institutional Review Board regarding the content of the study, privacy of the panelists, benefits of the study, and compensation for the panelists, prior to the focus group discussion (Appendix B). A moderator facilitated the discussion according to a previously planned discussion guideline (Figure 3.1). After the introduction, the moderator initiated the discussion by asking warm-up questions, followed by probing questions, and concluded the discussion with acknowledgements. The discussion guideline was developed based on the recommendations of Lawless and Heymann (1997) and Resurreccion (1998). Panelists were notified ahead of time that the sessions would be recorded with audio and video devices.

Data Analysis

The focus group discussion was analyzed with audio and video recordings and written notes. The audio and video recordings were transcribed and reviewed by two people. The transcripts were then edited for clarity and summarized by removing comments unrelated to the discussion. The written notes from panelists and two note-takers including the moderator were also included in the data analysis.

3.4. RESULTS AND DISCUSSION

Awareness of and Interest in Ginseng Food Products

Panelists recognized ginseng as a large part of Eastern medicine. Most panelists were aware that ginseng is usually used for boosting energy and stamina. A few panelists mentioned production of male reproductive tissues, stress relief, and improvement of the immune system. However, these did not come from panelists' actual experiences but simply from hearsay knowledge.

The number and types of ginseng food products that panelists have seen in local stores or have consumed were limited to energy drinks and teas, i.e., "Monster" energy drinks or "Arizona" beverages. Only two panelists added protein bars and smoothies into the products containing ginseng that they have seen in local stores.

The majority of participants in the focus group interviews lacked knowledge about ginseng and its health benefits. Most panelists recognized increase in energy and stamina as a major health benefit of ginseng, although panelists did not experience these health effects firsthand from ginseng food products. This perception seems to be influenced by the growth in sales of energy drinks that contain ginseng, which are advertised as providing energy to improve physical activity. However, U.S. consumers have limited opportunity to learn and experience the health effects of ginseng due to the limited number and types of ginseng food products available in the market. There have been few studies showing differences in consumer perception about ginseng between Western and Asian people. However, people in Asian countries are relatively much more exposed to various ginseng food products like ginseng concentrate (extract), candies, chocolates, chewing gums, jellies, root slices preserved with honey, and cookies, as well as drinks and teas (Yang 1996).

Factors Influencing Purchase Intent of Ginseng Food Products

Most panelists have only had a few experiences in purchasing ginseng food products. The popularity of the product brand was the primary factor that panelists considered when choosing ginseng food products. Information from packaging labels such as ingredient lists and nutrition facts, as well as price also affected their purchase intent. Moreover, specific circumstances, such as during a final exam period, were other factors for purchasing ginseng food products—in particular, energy drinks. Some panelists answered that they selected ginseng food products not for ginseng itself but for other ingredients in the products. Most panelists stated that the varieties and origins of ginseng would not affect their decision in purchasing the products because they knew little about the differences among different varieties and origins of ginseng.

Previous research shows that healthiness, taste, safety, familiarity, convenience, and price of food products are important factors to consumers in purchasing functional or healthy foods (Wrick and others 1993; Cardello and Schutz 2003; Urala and Lahteenmaki 2003). In addition to these factors, panelists participated in the focus groups emphasized the popularity of the product brand and information presented on the packaging as factors affecting purchase intent toward ginseng food products. Product brand is a powerful cue for consumers for predicting the quality of the product (Grunert 2005). Moreover, the food label is a way for consumers to acquire knowledge about the food that they consider buying, and frequency of label reading is in proportion to the degree of uncertainty about the food (Wandel 1997). Accordingly, these factors indicate that the ginseng food product that is manufactured by a popular brand-name company and provides detailed nutritional information can increase credibility for the products and reduce aversion to ginseng, which is recognized as an unfamiliar ingredient to Western population. On the other hand, emphasizing ginseng as an ingredient on the packaging should be cautiously considered. Ares and others (2008) have reported that providing information on the source of functional ingredients in dairy products was not recommended, as consumers expected negative tastes, and therefore, their willingness to purchase could decrease with this particular information. Because undesirable flavors of ginseng food products are still one of the major obstacles to consumers, highlighting ginseng on packaging as an ingredient may negatively affect consumers' intent to purchase. Our finding that some panelists selected ginseng food products not for ginseng itself but for other ingredients contained in the products implies that ginseng as an ingredient may not be the factor which drive consumer interest. This finding also agreed with a previous report which showed that 54 % of U.S. consumers responded that ginseng was not the main reason why they sought the functional foods containing ginseng (Mintel 2009).

Packaging Evaluation of Commercial Ginseng Food Products

Commercial Ginseng Food Products Sold in the United States

For packaging evaluation, three commercial ginseng food products sold in the United States were presented to the panelists. Red and yellow colors of the ginseng teabag product packaging (UG1) were evaluated as giving a "warm and energetic" impression. Green and yellow colors on the ginseng beverage product packaging (UG2) gave a "natural" impression to panelists. Meanwhile, purple and pink colors used on the packaging of the UG3, which emphasized male enhancement in the product name, did not appeal to panelists because men generally do not like tea products, and pink and purple colors are considered more suitable as products for women.

In regard to wording on packaging, panelists disliked words like "male elixir" and "manhood" on the packaging (UG3) because the words reminded people of a certain late-night advertisement for "male enhancement". Some Chinese characters on the packaging (UG2), which mean a healthy tea, gave an oriental and international perception to the panelists.

Nutrition facts and ingredient lists were also important factors that affected panelists' packaging evaluation. Most panelists liked packaging that provided more detailed nutrition and ingredient information. For example, scientific terms like ORAC (oxygen radical absorbance capacity) written on packaging (UG2) gave a more reliable impression to panelists. Panelists requested more detailed health claims about ginseng on the packaging because they had little knowledge about ginseng and its purported health benefits.

Commercial Korean Red Ginseng Food Products

Four Korean red ginseng food products were also evaluated for their packaging. Overall, panelists thought that the packaging looked fancy and expensive. However, some panelists mentioned that the packaging was too excessive and wasteful, and the size of the products was too large for individual use.

Gold and red colors predominant on the packaging (KG1 and KG3) gave an impression of energy and authenticity. However, specific colors on the packaging misled panelists about contents of the products. A light red color used on ginseng hard candy packaging (KG4) reminded panelists of strawberry candy and a reddish-brown color on ginseng chocolate packaging (KG3) made people believe that the product was either milk or dark chocolate; however, it contained crunchy white chocolates. An opaque black glass bottle of the Korean red ginseng extract tea (KG1) should be replaced with a transparent material because most Americans are unfamiliar with this type of product, which is sticky liquid, and might want to see the inside before purchasing it. Panelists recognized pictures of ginseng berries and leaves on the packaging (KG2) as common flowers, indicating that they had little knowledge of the complete shape of ginseng.

The word, “premium” on the packaging of most Korean red ginseng food products studied reminded panelists of an advertisement through junk mail. Panelists wanted to know the definition of “red” ginseng, and the differences between “red” ginseng and regular ginseng. They also inquired about “6-year-old” ginseng roots, which were emphasized on the packaging of all Korean red ginseng food products. Panelists suggested that health claims of Korean red ginseng should be described on the packaging to help consumers’ understanding.

For nutrition facts and ingredient lists, Korean red ginseng extract tea (KG1) was thought most reliable and healthy among the four products because there were no artificial ingredients in the product. Some panelists were skeptical about other Korean red ginseng food products being as healthy as they claimed, because the products contained sugar, corn syrup, and/or artificial flavors. Furthermore, ginseng content (1.2 %) in Korean red ginseng hard candy (KG3) and chocolate (KG4) was deemed too small to label them healthy foods.

Most panelists expressed their intent to purchase the ginseng food products only as a gift, and not for their own consumption. They answered that the fully packaged products looked expensive and the sizes of the products were generally too large for their individual use.

The findings from the focus group suggest that warm colors, such as red, yellow, and gold, which give impressions of energy and authenticity, should be used for packaging of new ginseng food products. Manufacturers need to carefully use appropriate colors, with which consumers are able to infer content inside the packaging, because most U.S. consumers have few experiences in purchasing ginseng food products. With regard to packaging size, small and convenient type of packaging such as UG1 is more favorable to consumers, when compared to excessive and expensive packaging as found in most Korean red ginseng food products. Previous research has found that packaging size was the most important factor for U.S. consumers in purchasing ginseng food products (Jeong and others 2005). Some Asian characters on packaging are also effective in providing an appearance of oriental image, and hence, authenticity to consumers.

Most panelists in the focus groups were ignorant about the terms used on packaging, such as “red” ginseng and “6-year-old” ginseng roots. Information on the packaging such as “Red ginseng is processed by steaming and drying, and characterized by reddish brown colors” (Kim and others 2002; Angelova and others 2008), “Red ginseng has more enhanced pharmacological activities and milder ginseng flavors than regular ginseng” (Cho and others 2008), and “6-year-old ginseng roots have the highest quality in terms of both pharmacological effects and exterior shape” (Koo and others 2005) will have a positive effect on consumers’ purchase decision with respect to ginseng food products.

Consumer Needs of the Health Claims on Packaging of Ginseng Food Products

Due to the unfamiliarity of ginseng to consumers, more health claims and a brief description of ginseng should be shown on packaging of new ginseng food products to provide information about the ingredient. Newsholme (2002) reported that unfamiliarity and a lack of understanding about the ingredients were the greatest barriers for functional foods to be purchased. Previous studies also reported that health claims on packaging approved by the government positively influenced consumers' attitudes toward the products and intent to purchase (Ford and others 1996; Bruhn and others 2002; Kozup and others 2003; Wansink 2003; Williams 2005).

Regulations of ginseng products and their labeling have not been solidly established yet in the United States. Furthermore, any pharmacological effects of ginseng have not been approved by the Food and Drug Administration (FDA), which has the authority to regulate labels including nutrition information and health claims on the package of functional foods as well as dietary supplements under the Federal Food Drug and Cosmetic Act (Title 21 of the Code of Federal Regulations). Consequently, statements of health claims of most herbal substances including ginseng on the package are prohibited by the FDA. Alternatively, most functional food products as well as dietary supplements are permitted to state "dietary guidance" on their package rather than "health claims". The dietary guidance must not refer to a specific substance but rather refer to a broad class of foods without an expressed or implied connection to a specific substance that is present, or may refer to a specific food or food component but must not refer to a disease or health-related condition (21 CFR 101.14). Moreover, the Act stipulates that a dietary supplement should bear statements on the package, including "This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease" (21 CFR 101.93). With regard to declaration of ginseng on the package as an ingredient, the Title 21 United State Code 343.403 (21 USC 343.403) states, "a food shall be deemed to be misbranded if it purports to be or is represented as ginseng, unless it is an herb or herbal ingredient derived from a plant classified within the genus *Panax*". Further, in 2002, two paragraphs were added into the statement, which include "the term 'ginseng' may only be considered to be a common or usual name (or part thereof) for any herb or herbal ingredient derived from a plant classified within the genus *Panax*" (Public Law 107-171.10806(b)(1)(A)) and "only labeling or advertising for herbs or herbal ingredients classified within that genus may include the term 'ginseng'" (Public Law 107-171.10806(b)(1)(B)). However, the FDA has withdrawn the limited use of "ginseng" as of December 28, 2005 (FDA 2005), which means that the term, "ginseng" can be used for Siberian ginseng

(*Eleutherococcus senticosus*), which has been commonly recognized as not true ginseng (Mar and Bent 1999).

Sensory Attributes of Korean Red Ginseng Food Products

Five Korean red ginseng food products were evaluated in order to generate sensory descriptive terms of the products, which were used for understanding U.S. consumers' sensory perception of ginseng food products. The descriptive terms are shown in Table 3.3. Korean red ginseng extract tea (KG1) was mainly described as honey, molasses, earthy, woody, and medicinal for the aroma modality, and as diluted sugar solution, honey, licorice, herbal, woody, and earthy for the taste and aroma-by-mouth modalities. For bitterness of the ginseng tea, panelists felt that it was not very bitter at first but the bitterness lasted for a long time, which was different from that of coffee. Panelists also identified that bitterness in ginseng was followed by a taste of sweetness at the end of the perception. Overall, panelists answered that the tea was not noticeably different from common tea products.

Korean red ginseng crunchy white chocolate (KG3) was described as stale chocolate and perceived as a low quality product in terms of appearance and taste. Panelists detected chemical, coffee, brown sugar, and fudge attributes for the aroma category, and buttery, rice puff, coffee, creamy, and nutty characteristics for the aroma-by-mouth category. The product was thought to be similar to the Nestlé crunch bars or other crunchy wafers due to the presence of rice puffs in the product. White chocolate did not complement ginseng flavors; rather, the ginseng flavors masked the sweetness of the chocolate.

Panelists were unfamiliar with the shape and color of Korean red ginseng root slices (KG5), which are ginseng root slices preserved in honey. They said that the ginseng root slices looked like dried potatoes or carrots. The aroma was very strong, which was described as molasses, sweet, smoky, woody, musty, potato, and burnt. The taste of the ginseng root slices was characterized as bitter, burnt, sweet, ginger, soy sauce, earthy, and honey. Most panelists, in particular, disliked the product texture, with the descriptions of the slices as being too gummy and sticky.

Korean red ginseng jelly (KG6) looked like apple candy or gumdrop-like candy to the panelists. The aroma of the jelly was characterized as cardboard, pungent, licorice, minty, smoky, and woody. Descriptors for taste were similar to the descriptors for aroma, which were cardboard, licorice, minty, smoky, and woody. In addition, brown sugar, citrus, medicinal, molasses, musty, and perfume were listed for aroma modalities and bitter, cinnamon, ginger, metallic, and spicy for taste modalities. Negative texture terms were developed for the product, with it being described as not chewy but bouncy, firm, and rough, and it broke down into smaller parts in their mouth.

For Korean red ginseng candy with vitamin C (KG7), panelists considered it more of a vitamin supplement than a food. Some panelists also responded that the product type was similar to Pez, which is a candy product. Artificial, fruity, and citrus characteristics were perceived by panelists. This product was considered to be the most acceptable to panelists in terms of sensory properties. At the same time, they also produced negative descriptors like musty, damp soil, cardboard, and storage basement in taste and aroma-by-mouth modalities. They characterized the product as being grainy, too hard, and chalky with regard to the texture category.

In general, bitter, molasses, and earthy characteristics were reported for Korean red ginseng food products. Asian people who have often experienced ginseng food products think that bitter and earthy flavors are positively associated with authenticity and pharmacological effects of ginseng. However, for Western people who have rarely experienced ginseng and have little information on it, presence of bitter, molasses, and earthy flavors may be a factor that demotes the acceptance level of the products. Flavor and texture are important factors influencing purchase decisions of health-targeted food products. Consumers may not buy and consume functional food products unacceptable in sensory qualities even if the products offer many health benefits (Gilbert 2000; Ares and others 2008; Barrios and others 2008).

New Ginseng Food Products for U.S. Consumers

Panelists were asked what ingredients could be added or what attributes should be masked to improve sensory acceptability of ginseng food products. According to the panelists, bitterness was one of the major off-flavors that needs to be masked in ginseng foods. To reduce bitterness, they suggested using more sweeteners, and preferred honey over sugar or artificial sweeteners in ginseng food products. Some panelists suggested that the bitterness of ginseng could be masked with different types of bitter ingredients like coffee and chocolate, which could be considered congruent flavors. Panelists also indicated that earthy, musty, and molasses flavors of ginseng food products should be removed or masked. Adding fruity, citrus, cinnamon, or ginger flavors into ginseng food products was recommended as a way to mask earthy and musty flavors. The panelists mentioned Korean red ginseng candy with vitamin C (KG7) as a desirable example of fruity flavors in a ginseng food product.

Previous studies suggest the addition of cyclodextrin to eliminate or mask bitterness of ginseng (Akiyama and Miyao 1979; Szejtli and Szente 2005; Lee and others 2008). However, there has been little to no research that reported the means to mask or reduce undesirable flavors like earthy, musty, and molasses flavors in ginseng food products. There have only been a few studies elucidating the relationship between the undesirable flavors and the corresponding volatile compounds. With respect to aroma, methoxypyrazine derivatives and some acids have been reported to contribute to earthy, floral, herbal, and moldy aroma in fresh or white ginseng (Iwabuchi and others 1984; El-Aty and others 2008). In red ginseng, earthy, floral, herbal, and moldy odors decreased while sweet and fragrant aroma increased with production of 3-hydroxy-2-methyl-pyran-4-one during heat processing (Lee and others 2005).

Lastly, panelists discussed potential ginseng food products that would have market success in the United States. Panelists listed cookies, snacks, cereals, and energy bars as the potential products. For cookies and snacks with ginseng, they would like to see products with additional flavors, such as ginger. Dark chocolates and coffee were suggested as possible media to add ginseng, as both ginseng and these products share bitter taste. There was a strong suggestion that the directions for the development of new ginseng food products should be based on preexisting product types, such as cookies, snacks, cereals, energy bars, chocolates, and coffee rather than innovative or unfamiliar product types. The specific product types like Korean red ginseng root slices (KG5) and Korean red ginseng granular tea (KG2) deemed to not appeal to U.S. consumers because such food product types were unfamiliar to them and gave unpleasant impressions to panelists. The panelists suggested that ginseng food products should be marketed for younger and/or health-conscious people, and would need more advertising and marketing so as to educate U.S. consumers about the potential health benefits of ginseng.

3.5. CONCLUSIONS

U.S. consumers need to be educated in terms of the health benefits of ginseng and various types of ginseng food products through advertisements, media stories, and labels on the packaging of these products. In order to prevent an aversion to unfamiliar product types, new ginseng food products should be developed on the basis of preexisting food product types. Reduction in bitter, earthy, musty, and molasses flavors will increase acceptance levels of new ginseng food products. Future studies using a conjoint analysis may identify specific product types that will have potential for success in the U.S. market by quantitatively analyzing consumers’ expectations. A consumer acceptance test and a descriptive analysis with commercial ginseng food products may also identify which attributes are drivers of liking or disliking in these products, and eventually apply the results to developing successful new ginseng food products. Additional focus groups with different age groups—in particular, the elderly—could be conducted in order to compare the different attitudes about ginseng food products by different age groups and to apply the results to target specific market segment.

3.6. TABLES AND FIGURES

Table 3.1. Commercial ginseng food products used for packaging evaluation

Product code	Product picture	Product type	Packaging type and size	Color	Major ingredient[§]
UG1		Ginseng tea	10 Teabags in a paper box (7.8 × 6.8 × 6.5)[†]	Red, yellow, blue	Eleuthero, American ginseng, Asian ginseng, chamomile, spearmint, roasted barley
UG2		Green tea with ginseng and honey	Ready-to-drink tea in a glass bottle (532 mL)	Green, yellow	Filtered water, crystalline fructose, honey, green tea extract, citric acid, ascorbic acid, yerba mate, *Panax ginseng* root extract
UG3		Herb tea with ginseng	20 Teabags in a paper box (11.8 × 7.8 × 6.8)	Purple, pink, green	Broomrape, wild *Rhodiola*, *Panax ginseng*, *Astragalus*, *Cynomorium*, *Ginkgo biloba* leaf, tender green tea leaf, jasmine flower
KG1		Korean red ginseng extract tea	Liquid ginseng extract in a bottle in a paper box (6.5 × 6.9 × 8.0)	Gold, red, black	Korean red ginseng (6-year-old) extract 100 %

(continued from Table 3.1)

Product code	Product picture	Product type	Packaging type and size	Color	Major ingredient
KG2		Korean red ginseng granular tea	50 Packs of granular type of ginseng extract in a paper box (14.2 × 17.0 × 5.9)	Blue, gold, red	Korean red ginseng (6-year-old) extract 10 %, glucose, lactose, vitamin C
KG3		Korean red ginseng crunchy white chocolate	Crunchy white chocolates wrapped individually in a paper box with strings (16.8 × 25.0 × 5.0)	Brown, gold, black	Korean red ginseng (6-year-old) extract 1.2 %, sucrose, milk, cocoa butter, palm oil, wheat flours, corn starch, vanilla, lecithin, red ginseng flavor
KG4		Korean red ginseng hard candy	Candies wrapped individually in a paper cylinder (7.5 × 7.5 × 11.5)	Red, pink, gold	Korean red ginseng (6-year-old) extract 1.2 %, sucrose, corn syrup, isomalto-oligosaccharide, xylitol, red ginseng flavor, L-menthol

[§] From ingredient lists shown on product packaging.
[†] cm × cm × cm.

Table 3.2. Commercial Korean red ginseng food products used for sensory evaluation

Product code	Product type	Major ingredient[§]
KG1	Korean red ginseng extract tea	Korean red ginseng (6-year-old) extract 100 %
KG3	Korean red ginseng crunchy white chocolate	Korean red ginseng (6-year-old) extract 1.2 %, sucrose, milk, cocoa butter, palm oil, wheat flours, corn starch, vanilla, lecithin, red ginseng flavor
KG5	Korean red ginseng root slices preserved with honey	Korean red ginseng (6-year-old) 51 %, honey, isomalto-oligosaccharides, fructose
KG6	Korean red ginseng jelly	Sucrose, oligosaccharides, agar, Korean red ginseng extract (6-year-old) 1.0 %, herbal flavors, L-menthol
KG7	Korean red ginseng candy with vitamin C	Korean red ginseng (6-year-old) powder 2 %, glucose, citrate, dextrin, magnesium stearate, aspartame, vitamin C, natural colors

[§] From ingredient lists shown on product packaging

Table 3.3. Sensory descriptors for Korean red ginseng food products

Appearance	Aroma	Aroma-by-mouth/ Taste	Aftertaste	Texture
Korean red ginseng extract tea (KG1)				
Amber color	Chemical	Bitter	Bitter	
Light brown	Earthy	Diluted sugar solution	Chemical	
	Herbal	Earthy	Lingering	
	Honey	Herbal	Milky	
	Medicinal	Honey	Smoky	
	Molasses	Licorice	Tart	
	Pungent	Medicinal		
	Spicy	Sweet		
	Tart	Tart		
	Urine	Woody		
	Woody			
Korean red ginseng crunchy white chocolate (KG3)				
Bumpy	Brown sugar	Buttery	Bitter	Buttery
Creamy	Chemical	Coffee	Medicinal	Crunchy wafer
Maple fudge	Coffee	Creamy	Roasted	Nestlé crunchy bar
Milky	Fudge	Crunchy wafer	Stale	Peanut butter
Stale chocolate	Smoky	Milky		
Smooth	Tingly	Nutty		
	Toffee	Rice puff		
		Sweet		
		Sugary		
Korean red ginseng root slices preserved with honey (KG5)				
Candy	Burnt	Bitter	Bitter	Chewy
Dark orange color	Herbal	Burnt	Long lasting	Gummy
Dried potato/carrots	Molasses	Earthy		Sticky
	Musty	Ginger		Tender
	Potatoes	Honey		
	Pungent	Overripe vegetables		
	Smoky	Potatoes		
	Sweet	Smoky		
	Woody	Soy sauce		
		Sweet		

(continued from Table 3.3)

Appearance	Aroma	Aroma-by-mouth/ Taste	Aftertaste	Texture
Korean red ginseng jelly (KG6)				
Amber color Apple candy Gumdrop candy	Brown sugar Burnt Cardboard Citrus Ginseng Licorice Medicinal Minty Molasses Musty Pungent Perfume Smoky Tangy Tea Woody	Bitter Cardboard Cinnamon Ginger Licorice Metallic Minty Orange spice drop Smoky Spicy Woody		Bouncy Firm Gelatinous Gummy Rough Squishy Sticky
Korean red ginseng candy with vitamin C (KG7)				
Chalky Flintstones vitamin Pez candy	Artificial flavors Citrus Fruity Strawberry	Cardboard Citrus/lemon Damp soil Ginger Molasses Musty Smoky Storage basement Sugary Sweet Tart Woody	Sweet	Chalky Dry Grainy Hard Powdery

Figure 3.1. Moderator's guide: focus group on ginseng food products

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1. **INTRODUCTION (5 min)**

   1.1. Moderator's introduction
   a. General nature and purpose of a focus group
   b. Role of the moderator

   1.2. Objectives of this focus group

   1.3. Ground rules
   a. State name each time one speaks, confidentiality.
   b. Free to participate or not participate at any time.
   c. One person talking at a time.
   d. Respect others' opinions.

   1.4. Mention incentive and taping of the focus group

2. **WARM-UP: "To get everyone acquainted with one another and to get us all thinking about the topic of interest, please…"**

   2.1. Self-introduction
   a. State your name.

   2.2. Interest on the topic
   a. Briefly describe the functional foods that you have consumed recently. (5 min)
   b. What is the expectation when you consume and purchase those functional foods besides regular meals? (5 min)

3. **PROBING QUESTIONS**

   3.1. Awareness of and interest in ginseng food products
   a. Briefly, describe health effects of ginseng that you know or have heard of. (5 min)
   b. What types of ginseng food products have you seen in the local grocery stores in the U.S? (5 min)
   c. Among those ginseng food products, what products have you consumed? (5 min)

   3.2. Factors affecting purchase intent of ginseng food products
   a. What factors influenced you to purchase or consume those ginseng foods? (5 min)
   b. How do varieties of ginseng and manufacturers of the products affect your purchasing ginseng food products? (5 min)
   c. *(Presenting four Korean red ginseng food products and three of the best and worst packaging products)* Please look at 7 commercial ginseng food products. What is your opinion in words, pictures, or colors on the packaging and container's shape? (15 min)

   3.3. Sensory attributes of ginseng food products, and prospective ginseng food products

(Continued from Figure 3.1)

a. *(Presenting ginseng root slices, extract tea, jelly, chocolate, and candy with vitamin C)* Taste five samples. Describe the sensory attributes you perceived from the five products. (15 min)
b. What ingredients do you think can be added or what attribute do you think should be masked to improve sensory acceptability of those products? (5 min)
c. When you consider our discussion about health effects, current commercial products, and sensory properties of ginseng, what types of ginseng food products do you think will have market potential for U.S. consumers? (5 min)

4. CLOSE (5 min)

4.1. If you would like more information about ginseng food products, you can contact us.
4.2. Thank you for your time.
4.3. Distribute incentive.

3.7. REFERENCES

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CHAPTER 4. GINSENG FOOD PRODUCT CONCEPT TESTING BY CONJOINT ANALYSIS

4.1. ABSTRACT

Ginseng has been widely used as a traditional medicine as well as a food ingredient in Asian countries for more than 2000 years. However, use of ginseng in food products is limited and still unfamiliar to U.S. consumers. The objectives of the study were to: 1) identify ginseng food product(s) that will possess market potential in the United States and 2) segment consumers based on the pattern of their responses to the concept elements by conjoint analysis. Conjoint analysis was conducted with an Internet-based survey, in which 400 people participated. Four categories and five elements from each category were employed. The additive constant for the entire panel was 20, indicating a low level of initial interest in ginseng food products. “Sweet (5.9)” and “ginseng chocolate (4.8)” had the highest utility values. “Bitter (-13.6)” and “earthy flavor (-5.2)” were the elements which received the lowest utility values. Respondents were divided into three segments. Segment 1 (n = 191) was more interested in the sweetness of ginseng food products and segment 2 (n = 118) paid more attention to ginseng energy chocolate, honey, and cinnamon. Segment 3 (n = 91) had high additive constant (52), indicating high initial interest in ginseng food products; however, none of the elements attracted their interest. Findings from this study suggest that ginseng food products to be developed should be improved in their sensory characteristics by masking bitterness and earthy flavors, and adding sweeteners and fruity flavors in order to increase consumers’ purchase intent. A ginseng chocolate product is suggested as a potential product type to be successful in the U.S. market. Future studies may include another conjoint analysis investigating more specific categories for the development of a ginseng chocolate, such as ingredients, types of chocolate, and price. A consumer acceptance test and a descriptive analysis with commercial ginseng food products may further be conducted to identify which sensory attributes most attract consumers.

Key words: ginseng, bitterness, sweetness, chocolate, conjoint analysis

4.2. INTRODUCTION

Functional food sales are increasing with numerous claimed health benefits of the functional food ingredients (Goldberg 1999; Hardy 2000). Globally, total estimated sales of functional foods reached $75 billion in 2007, and has been expected to grow to $109 billion by 2010 (Sloan 2008). Functional foods are defined by the Institute of Medicine of the U.S. National Academy of Sciences in 1994 as, “those foods in which the concentrations of one or more ingredients have been manipulated or modified to enhance their contribution to a healthful diet” (Katan and Roos 2004). Processed functional food products sold in the market are varied, and include dairy products, baby foods, breakfast cereals, snack bars, breads, confectioneries, soft drinks, teas, and alcoholic beverages (Menrad 2003; Katan and Roos 2004; Sloan 2008). The source of functional ingredients used in these foods are also broadly distributed, such as soybeans, green tea leaves, herbal extracts, seaweeds, *Lactobacillus* bacteria, marine oils, cereal grains, eggs, fruits, and vegetables (Hasler 2000, 2002; Katan and Roos 2004).

Ginseng has been one of the top-10-selling herbal dietary supplements in the United States since 2003, when the data collection began (Mintel 2008). Ginseng contains ginsenosides, which are known to have positive health effects on humans. Pharmacological effects of ginsenosides include immunomodulatory effects (Kenarova and others 1990; Kim and others 1990), anti-fatigue characteristics (Saito and others 1974), improvement of memory and learning (Salim and others 1997; Li and others 1999), growth inhibitory effects against tumor cells (Yun and Choi 1995; Duda and others 1996), an increase in the number of spermatozoa and their mobility in humans (Salvati and others 1996), and improvement of the recovery response from physical work or aerobic exercise performance (Engels and others 1996; Engels and Wirth 1997). The total ginsenoside content of a root varies between 0.7 and 20 % (Attele and others 1999; Corthout and others 1999), and approximately 30 ginsenosides have been found in ginseng (Schlag and McIntosh 2006). There are two varieties of ginseng commonly used for dietary supplements and food ingredients, which are Asian ginseng (*Panax ginseng* C.A. Meyer) and American ginseng (*Panax quinquefolius* L.) (Shibata and others 1985; Assinewe and others 2003). The profiles of ginsenosides as well as the pharmacological effects vary between the two varieties of ginseng. American ginseng has little ginsenoside Rf and a lower ratio of ginsenoside Rg_1 to Rb_1 than Asian ginseng. Therefore, the ratio of ginsenoside Rg_1 to Rb_1 has been used to distinguish the two varieties of ginseng (Corthout and others 1999). Ginsenoside Rg_1 has been known to stimulate the central nervous system and increase immune responses, and ginsenoside Rb_1 to depress the central nervous system and prevent inflammation (Shibata and others 1985; Kenarova and others 1990; van Breemen and others 1995; Harkey and others 2001; Xu and others 2003).

Consumers are increasingly turning to their diet to improve their health. A recent statistical report shows that 76 % of U.S. consumers studied believe that eating healthfully is better to manage illness than using medication (Hasler 2002). Thus, functional food opportunities are largely consumer-driven (Verbeke 2005). Consumers' decision on purchasing functional foods is influenced by various factors, including consumers' familiarity with ingredients, manufacturers, taste, and price, as well as health benefits of the products (Cardello and Schutz 2003; Verbeke 2006). Therefore, ultimate market success for functional foods depends on the degree to which the new food product reflects consumers' needs (van Kleef and others 2002). However, from a view point of manufacturers, functional food development is a difficult process because it is much more involved with scientific standards and food technological complexity than traditional food development (van Kleef and others 2002).

Conjoint analysis is a useful research technique for predicting consumer needs and identifying the driving elements of subjects' responses regarding their preferences for specific products or product concepts (Moskowitz and others 2005b; van Kleef and others 2005). The mathematical basis for conjoint analysis was first introduced by Luce and Tukey (1964), and the concept was first applied to the market by Green and Rao (1971). The basic principle of conjoint analysis is to reduce respondents' reactions to a concept down to the relative importance of each element belonging to the concept by deriving part worth estimates according to a pre-specified utility model (Reutterer and Kotzab 2000). Another advantage of conjoint analysis is that it allows researchers to identify market segmentation. Concept-response segmentation is a method of market segmentation, which divides people into meaningful, relatively similar, and identifiable segments (Moskowitz 2003). By segmenting respondents, market researchers discover new groups of respondents who can be better targeted by marketing programmers and/or identify homogeneous groups of individuals who may share similar preferences for the products (Moskowitz and others 2002). Market researchers should thoroughly understand the differences among people in a population. Market segmentation facilitates the development of effective products directed toward subpopulations with relatively well-defined sets of preferences and needs (Spoth and others 1996). Presently, most conjoint analysis is conducted via the Internet, and the Internet-based research has grown extensively world-wide due to the low cost, ease of data acquisition, efficient and expedient access to respondents, and general simplicity of the entire process (Moskowitz and others 2005a; Moskowitz and Silcher 2006).

In the food industry and in academic settings, conjoint analysis has been conducted in order to identify consumers' liking and disliking, and to gauge their intent to purchase food products or food product concepts. Recently, conjoint analysis was employed to understand consumers' responses to the development of new food products containing functional ingredients, such as soy proteins (Lee and others 2007; Childs and others 2008), vegetables (Di Monaco and others 2007), dairy products (Haddad and others 2007; Ares and others 2009; Childs and Drake 2009), and fish oils (Cox and others 2008). However, there has been little research investigating consumer responses to ideas for ginseng food products. Previous ginseng studies have mainly focused on its pharmacological effects. From a practical standpoint, ginseng food products in the United States are mostly limited to beverages, and the number of consumers who have consumed ginseng and related food products is relatively lower when compared to other functional foods. The objectives of the study were to: 1) identify ginseng food product concept(s) that possess market potential in the United States and 2) segment consumers based on the pattern of their responses to the concept elements by using conjoint analysis.

4.3. MATERIALS AND METHODS

Internet-based Survey

This study was run on the Internet using the IdeaMap.Net® software (Moskowitz Jacobs, Inc., White plains, NY, USA) and was composed of a concept evaluation and a demographic questionnaire. Four categories and five elements from each category were used in this study, which have been determined based on the preceding focus group discussion (Chung 2010). The categories and elements are listed in Table 4.1. A participant was presented a total of 21 concepts, consisting of two to four elements per concept, with only one or no elements from each category. The combinations of elements were randomized across participants, and the presentation order of the concepts was different across participants.

The email included a brief description about the survey, and a web link was sent to the participants, who were directed to the survey by clicking on the link. The first webpage, which was the welcome screen, stated the purpose, confidentiality, and length of the survey. Following the welcome screen, panelists viewed concepts continuously presented on the screen and rated their likelihood of purchase of the concept product on a 9-point scale, from “1 = not likely at all”, to “9 = very likely”, for each concept. Upon completion of the concept evaluation, participants were asked about their demographic information, as well as their consumption history and knowledge of ginseng food products. The total survey took 10 to 15 minutes to complete.

Survey Participants

Participants for the conjoint analysis were recruited via an email sent to students, staff, and faculty of the University of Illinois at Urbana-Champaign. A total of 400 participants completed the survey and their demographic distribution is shown in Table 4.2. Participants were given a chance to win one of six gift cards valued at $20 if the participant entered his/her email address.

Statistical Analysis

Ratings from each participant on the product concepts were transformed into two different scales, a persuasion scale and an interest scale, and then analyzed at the individual level using dummy variable regression—a feature of ordinary least square (OLS) regression (Gofman 2006; Moskowitz and others 2006). The data from each respondent generated a simple linear additive model, written as;

$$Y = k_0 + k_1 \cdot E_1 + k_2 \cdot E_2 + \ldots + k_{20} \cdot E_{20}$$

where Y = utility value for the concept, k_0 = additive constant, k_1 to k_{20} = utility value for the element, and E_1 to E_{20} = if the element is present in the concept "1", if not present "0".

The persuasion scale is created by multiplying the original rating (1–9) by 11 to transform the original rating into an 11–99 point scale (Moskowitz and others 2005a). The persuade scale of individual ratings is used to determine the intensity or magnitude of acceptance (Gofman 2006). The additive constant (k_0) for the persuasion scale represents the baseline interest in concept acceptance if no element is present in the concept. The utility values (k_1 to k_{20}) from the persuasion scale refer to the increment or diminution level of concept acceptance if the elements are to be introduced into the concept (Moskowitz and others 2006). Researchers who are interested in the mind of the individual consumer place more weight in the interpretation of the persuasion scale (Gofman 2006). Meanwhile, the interest scale of individual ratings is established by transforming the original ratings from participants to a binary value, either 0 or 100. Ratings from 1 to 6 are set to "0" and ratings from 7 to 9 are transformed to "100" (Moskowitz and others 2005a). The interest scale focuses on the number of individual interests rather than on the intensity of the interest (Krieger and others 2003). The additive constant (k_0) for the interest scale is the conditional probability of a respondent being interested in the concept before the respondents are exposed to any elements. Moreover, the individual utility values (k_1 to k_{20}) from the interest scale represent the conditional additive probabilities of the elements. Results from the interest scale are very practical to the market researchers because they are not interested in intensity of interest but rather, pay more attention to counting the number of individuals who are positive toward the concept (Moskowitz and others 2005a; Gofman 2006). Either in the persuasion scale or the interest scale, the additive constant (k_0) is a theoretical and estimated value because all concepts presented to respondents consist of two to four elements. The individual utilities, k_1 to k_{20}, can be positive or negative. The positive utility value means that the element adds to interest and the negative utility value represents that the element detracts from interest (Krieger and others 2003; Moskowitz and others 2006).

Validity of the data was measured with the degree to which the respondent was consistent in the ratings that he assigned (Moskowitz and others 2003). The consistency can be assessed through the goodness-of-fit statistic, which is Pearson multiple R^2. The R^2 is computed on the persuasion model, which is obtained by the OLS regression generated with the persuasion scale of individual ratings and shows the percentage of variation in the ratings accounted for by the presence or absence of the concept elements (Moskowitz and others 2003; Moskowitz and others 2005a). The R^2 provides information on how many respondents are a good fit to the persuasion model created for each respondent. The computed R^2 value varies from 0 to 1 and if the respondent is consistent in the ratings then the R^2 value should approach 1.

Respondents were segmented into statistically homogenous groups on the basis of the persuasion model of individual ratings because the persuasion scale showed the intensity of a respondent's feelings toward a concept and uses all the data from respondents, unlike the interest scale, which was transformed into a binary format (Moskowitz and others 2006). Segmentation was performed by using an agglomerative hierarchical cluster analysis by the Euclidean distance for the dissimilarity scale by the Ward's method. The cluster analysis was performed by XLSTAT (version 2008, Addinsoft, New York, NY, USA). After that, additive constant and utility values of elements within each segment were calculated on the basis of the interest model of individual ratings. This provides useful information to market researchers, who are more interested in the number of individual interests rather than on the intensity of the interest (Krieger and others 2003).

The relative importance index (RII) of each category for the entire panel and each of three segments was calculated by the following equation (Moskowitz and others 2002);

$$\text{RII (\%)} = \frac{\text{(sum of squared utility values within a category)}}{\text{(sum of squared total utility values)}} \times 100$$

This equation uses the sum of squares of the utility values, so that the larger the absolute value, either negative or positive, the greater the relative importance. Therefore, the RII shows how important each category is among categories in total respondents or each segment.

4.4. RESULTS AND DISCUSSION

Validity of Data from Respondents

The goodness-of-fit statistic was conducted to evaluate the quality of the data from each respondent. Generally, participants with coefficient of determination (R^2) above 0.66 are regarded as consistent in their evaluation (Moskowitz and others 2005a). Figure 4.1 shows that 96.8 % of respondents (387 out of 400) are consistent in their evaluation of concepts comprising different combinations of elements in this study. This indicates that the quality of the data is high at the individual respondent level.

Basic Interest in Ginseng Food Product Concepts

Table 4.2 shows the demographic distribution of 400 respondents, and additive constant values of the entire panel and subgroups, divided by their demographic information. The additive constant (k_0), which is calculated from the interest model of individual ratings, provides information on the acceptance of ginseng food products before any element was presented to respondents. The additive constant for the entire panel (n = 400) was 20, which means that 20 % of respondents were interested in the ginseng food products before they were exposed to any elements. Based on previous studies, $k_0 < 30$ means a low interest in the topic, $30 < k_0 < 50$ means a moderate interest, and $k_0 > 50$ means a high interest (Moskowitz and others 2004). Evidently, the topic, ginseng food products, evidently did not appeal much to our respondents. The constant value, 20, was relatively low compared to additive constant values identified in the conjoint analysis previously conducted with food products, which range from 27 to 44 (Moskowitz and others 2006). This points out that it will be necessary to identify elements that are able to lead consumers' interest toward using ginseng food products and incorporate these elements into the development of new ginseng food products.

There was neither a gender effect nor a marital status effect for the respondents' interest in the ginseng food products. In general, females were expected to have a stronger purchase interest toward functional foods (Verbeke 2005). However, findings from this study were not supportive of the previous report. The subgroups of 18 to 25 years old (+7), Asian (+7), and < $25,000 in income level (+9) had relatively more interest in the topic, when compared with the additive constant for the entire panel. On the other hand, respondents having 7-year-old or younger children showed relatively lower interest (-9) in ginseng food products than the additive constant for the entire panel. Additive constant values were also not linearly related among subgroups under each age group, period of residence in the United States, the number of children they have, their education level, and their income level. Analysis of variance (ANOVA) and *t*-test did not show any significant differences in the additive constant values among subgroups under any category. It was concluded that classification by demographical factors did not provide insight with respect to the development of new ginseng products.

Elements Driving Consumers' Purchase Intent – The Entire Panel

The top 5 and the bottom 5 elements for the entire panel, which were defined herein as winning and losing elements, are found in Table 4.3. Utility values ranged from 5.9 to -13.6, which indicate that there were no remarkable winning elements. Generally, utility values above 16 are considered as extremely important elements, 11 to 15 as very important, 6 to 10 as significant and relevant, 0 to 5 as having little impact, and below 0 as subtracting interest (Moskowitz and others 2003; Moskowitz and others 2004). "Sweet" in the category of "predominant sensory property" had the highest utility value (5.9), followed by "ginseng energy chocolate (4.8)" in the category of "product type", and "fruity flavors (3.7)" in the category of "predominant sensory property". This indicates that ginseng food products with sweetness will attract about 6 % more respondents. Ginseng energy chocolate was identified as a food product type that would draw interest of U.S. consumers the most among five product types examined in this study. This agreed with a previous report, in which chocolate was the most commonly craved food in North America (Bruinsma and Taren 1999). Meanwhile, the results more clearly identified losing elements rather than winning elements. "Bitter" in the category of "predominant sensory property" was revealed as the worst performing element (-13.6), which subtracted interest of 13.6 % of the respondents. Therefore, bitterness should be reduced or masked from new ginseng food products. "Earthy flavors (-5.2)" was also another losing element, which decreased respondents' interest. These findings indicate that consumers are more concerned with sensory attributes of ginseng food products, which further suggests that a new ginseng product should contain sweet and/or fruity flavors, but exclude bitterness and earthy flavors in order to be successful in the marketplace. Tuorila and Cardello (2002) and Verbeke (2006) have also reported that consumers do not compromise on taste for health reasons, although they know that they have to choose functional foods for many health benefits that such foods provide. Therefore, a key factor for success in the U.S. market will be to develop ginseng foods improved in sensory attributes by a process of eliminating or masking undesirable flavors, such as bitterness and earthy flavors.

Respondent Segmentation by Response Patterns to Concept Elements

Cluster analysis divided 400 respondents into three segments. The allocation of individuals to a segment was made only on the basis of the pattern of their responses to the concept elements—excluding respondents' demographic information and consumption history with ginseng. Table 4.4 shows utility values of the elements for each segment. Segment 1 (S1, n = 191) was the largest segment among the three. The additive constant of S1 (21) was not much different from the additive constant for the entire panel (20). The utility values of the elements in S1 ranged from -9.1 for "ginger" to 6.0 for "sweet". Respondents belonging to S1 were most interested in "sweet (6.0)" element, followed by "fruity flavors (2.9)" and "mixed herbal flavors (1.7)", which were in the category of "predominant sensory property". Segment 2 (S2, n = 118) had a negative additive constant (-6), demonstrating that people in this segment had little interest in ginseng food products before the elements were presented to them. However, S2 had relatively larger utility values of "ginseng energy chocolate (19.5)", "honey (13.7)", "cinnamon (13.5)", and "energy drink (12.8)". The lowest utility value in S2 was -8.5 for “bitter”. Segment 3 (S3, *n* = 91) was different from S1 or S2 in terms of the very large additive constant (52), which means that approximately 52 % of consumers of S3 were interested in the topic—“ginseng food products”. However, all utility values of the elements were very low, ranging from -38.2 for “bitter” to 0.8 for “major food company with American ginseng”. This illustrates that respondents belonging to S3 had a high initial interest in ginseng food products, but the elements used in this study failed to increase their interest. In order to further increase the interest of people belonging to S3, new elements should be explored. Findings from the segmentation demonstrate that ginseng chocolate or ginseng food products improved in their sensory characteristics by adding honey, cinnamon, or fruity flavors will lead a majority of consumers, who have similar mind-sets to respondents belonging to S1 and S2, to increase in consumption of the ginseng food products.

Relative importance index (RII) represents the degree of importance of each category relative to the others. RII for the entire panel, as well as for three segments, is shown in Table 4.5. Overall, the entire panel was most concerned with the category of “predominant sensory property (RII = 80.3 %)” and the least concerned with the category of “manufacturer and origin of ginseng (0.5 %)”. Segment 1 had the highest RII in the category of “additional ingredient (59.6 %)” followed by the category of “predominant sensory property (25.3 %)”. This was caused by relatively large negative utility values of the elements in the category of “additional ingredient,” such as -9.1 for “ginger” and -7.3 for “sugar” for S1. As for Segment 2, the two categories including “product type (43.5 %)” and “additional ingredient (29.8 %)” were ranked as the most important categories. Segment 3 considered “predominant sensory property (76.8 %)” as the most important category. This also resulted from large negative utility values of the elements under the category of “additional ingredient,” such as -38.2 for “bitter” and -21.9 for “earthy flavors” for S3. In summary, the categories involving tastes and flavors, such as “predominant sensory property” and “additional ingredient” were considered as relatively more important categories for all three segments, rather than the other categories, such as “product type” and “manufacturer and origin of ginseng”. Fortification of foods with bioactive compounds occasionally generates undesirable flavors and eventually decreases the sensory acceptance of the foods (Tuorila and Cardello 2002; Siró and others 2008).

However, the findings from this study revealed that consumers were more concerned about sensory properties of ginseng food products. Therefore, the sensory attributes of new ginseng food products should not be deteriorated by adding ginseng as an ingredient and should be even improved to be more acceptable to consumers and attract more interest of consumers than common food products.

Consumption Experience and Knowledge of Ginseng Food Products

For consumption frequency of any functional foods, 64 % of the respondents have consumed functional foods more than several times a month (Table 4.6). However, only 13 % of the respondents have eaten ginseng products more than several times a month. People that have never consumed ginseng products formed 21 % of respondents. The factors important to respondents when they purchased ginseng products were listed as taste (77 %), health effects of the products (65 %), and price (62 %).

Health conditions that respondents were mostly concerned about included cancer (48 %), lack of energy (38 %), high cholesterol (37 %), and obesity (36 %), which allowed respondents to choose multiple answers. The top four health effects of ginseng that the respondents had heard about were anti-fatigue (44 %), enhancement of memory (43 %), improvement of stamina (37 %), and enhancement of the immune system (32 %). However, people who have never heard about the health effects of ginseng made up 18 % of the respondents. A previous study (Hardy 2000) emphasized that better nutrition education was the key to long-term success of functional foods, as well as more comprehensive product information and labeling on products. Therefore, more education about the health benefits of ginseng through health professionals or the media deems necessary to increase interest in and consumption of ginseng food products.

4.5. CONCLUSIONS

A majority of consumers did not have a high initial interest in ginseng food products. More advertisement, marketing, and education are needed, in order to increase awareness of the health benefits of ginseng among U.S. consumers. Findings from the conjoint analysis illustrate that consumers do not forgo taste for the health benefits of functional foods. Consumers are more concerned about sensory attributes of ginseng food products. Bitterness and earthy flavors should be eliminated or masked in future ginseng food products. In particular, ginseng food products possessing sweetness are expected to increase consumers' likelihood of purchasing such products. The findings also revealed that chocolate products containing ginseng would be one of the ginseng food products that would be successful in this particular market. Future studies may include another conjoint analysis to employ more detailed categories for the development of ginseng chocolate, such as ingredients incorporated into the chocolate, types of chocolate, price, and packaging. A consumer acceptance test and a descriptive analysis with commercial ginseng food products may be conducted to identify which sensory attributes draw consumers to these products so that the results may be used to develop new, more palatable ginseng food products.

4.6. TABLES AND FIGURES

Table 4.1. Categories and elements used in the conjoint analysis

Category	Element
Product type	Ginseng energy bar Ginseng energy drink Ginseng energy cookie Ginseng energy chip/cracker Ginseng energy chocolate
Additional ingredient	Honey Sugar Herbs Ginger Cinnamon
Predominant sensory property	Sweet Mixed herbal flavors Fruity flavors Bitter Earthy flavor
Manufacturer and origin of ginseng	Made by a major food company with Asian ginseng Made by a company producing specialty foods with Asian ginseng Made by a major food company with American ginseng Made by a company producing specialty foods with American ginseng Made by an Asian food company with Asian ginseng

Table 4.2. Demographic information of 400 respondents participating in the conjoint analysis

	Base	Additive constant
Entire panel	400	20
Gender		
Male	109	19
Female	291	21
Age		
Under 18 years old	0	0
18–25	93	27
26–35	119	19
36–45	74	20
46–55	60	15
55–65	45	16
66 and over	9	4
Marital status		
Single	196	21
Married	204	20
Race (Mixed race heritage should check all that apply)		
American Indian or Alaska Native	4	-17
Asian	50	27
Black or African American	9	42
Caucasian	319	19
Hispanic or Latino	20	8
Native Hawaiian or other Pacific Islander	5	42
There is no answer applicable	5	-4
Resident period in the United States		
I was born and have lived in the U.S.	338	21
I was born outside the U.S. and have lived for 5 years or less.	30	33
I was born outside the U.S. and have lived for 5–10 years.	10	-11
I was born outside the U.S. and have lived for 10–20 years.	9	23
I was born outside the U.S. and have lived for 30 years or more.	6	-24
There is no answer applicable.	7	-7

(continued from Table 4.2)

	Base	Additive constant
Number of children		
I have no children.	227	22
I have one child or more than one child, and most of them are below 7 years old.	61	11
I have one child or more than one child, and most of them are above 8 and below 18 years.	39	23
I have one child or more than one child, and most of them are above 19 years old. They live at my home.	5	-10
I have one child or more than one child, and most of them are above 19 years old. However, they do not live at my home for school, job, marriage, etc.	59	15
There is no applicable answer.	9	65
Education level		
Some high school	0	0
High school graduate	14	9
Technical school	2	-7
Some college	69	25
Bachelor's degree (4-year college)	119	25
Post-graduate degree (master's or doctorate)	196	16
Income level		
Under $25,000	74	29
$25,000–$34,999	44	13
$35,000–$49,999	56	14
$50,000–$74,999	72	23
$75,000–$99,999	52	21
$100,000 and over	47	18
I prefer not to say.	55	17

Table 4.3. Winning (top 5) and losing (bottom 5) elements for the entire panel (*n* = 400)

Category	Element	Utility value
Winning elements (top 5)		
Predominant sensory property	Sweet	5.9
Product type	Ginseng energy chocolate	4.8
Predominant sensory property	Fruity flavors	3.7
Additional ingredient	Honey	2.2
Product type	Ginseng energy bar	1.2
Losing elements (bottom 5)		
Predominant sensory property	Bitter	-13.6
Predominant sensory property	Earthy flavor	-5.2
Additional ingredient	Ginger	-3.8
Additional ingredient	Sugar	-3.1
Additional ingredient	Herbs	-2.9

Table 4.4. Utility values of the elements for each of the three segments

Category/Element	Utility value		
	S1[§]	S2	S3
Base size (N)	191	118	91
Additive constant	21	-6	52
Product type			
Ginseng energy bar	0.2	**9.2**[†]	-7.2
Ginseng energy drink	-1.6	**12.8**	-10.0
Ginseng energy cookie	0.7	**6.8**	-8.9
Ginseng energy chip/cracker	-2.5	**8.3**	-8.6
Ginseng energy chocolate	1.4	**19.5**	-7.0
Additional ingredient			
Honey	-0.2	**13.7**	-7.3
Sugar	-7.3	**8.0**	-8.8
Herbs	-4.7	**6.8**	-11.5
Ginger	-9.1	**5.8**	-5.1
Cinnamon	-4.0	**13.5**	-5.4
Predominant sensory property			
Sweet	**6.0**	**12.6**	-3.2
Mixed herbal flavors	1.7	3.8	-18.6
Fruity flavors	2.9	**10.9**	-3.8
Bitter	-4.9	-8.5	-38.2
Earthy flavor	-1.4	1.6	-21.9
Manufacturer and origin of ginseng			
Made by a major food company with Asian ginseng	-1.6	4.8	-5.1
Made by a company producing specialty foods with Asian ginseng	-2.0	**5.1**	-0.1
Made by a major food company with American ginseng	-3.3	4.4	0.8
Made in a company producing specialty foods with American ginseng	-0.8	3.8	0.1
Made by an Asian food company with Asian ginseng	-3.8	3.1	0.7

[§] S1, S2, and S3 indicate segment 1, 2, and 3.
[†] The bolded values under each segment represent the utility values that are above 5.

Table 4.5. Relative importance index (RII) of each category for the entire panel and three segments

Category	Relative importance index (%)			
	Total	S1[§]	S2	S3
Product type	7.7	3.9	43.5	11.8
Additional ingredient	11.5	59.6	29.8	10.5
Predominant sensory property	80.3	25.3	21.3	76.8
Manufacturer and origin of ginseng	0.5	11.2	5.4	0.9

[§] S1, S2, and S3 indicate segment 1, 2, and 3.

Table 4.6. Consumption frequency and knowledge of ginseng and related food products

Question	Respondent (%)
Consumption frequency of any type of functional foods	
Everyday	16
Several times a week	25
Several times a month	23
Once a month	7
Several times a year	18
Once a year	5
I have never consumed any type of functional foods.	5
Consumption frequency of ginseng food products	
Every day	1
Several times a week	2
Several times a month	10
Once a month	9
Several times a year	34
Once a year	24
I have never consumed ginseng food products.	21
Important factors when purchasing ginseng food products (Check all that apply)§	
Convenience for use/consumption	37
Health effects of the products	65
Manufacturers of the products	15
Price	62
Tastes	77
Varieties or origins of ginseng	13
Other ingredients in the products	34
Health conditions most concerned about (Check all that apply)§	
Arthritis	21
Cancer	48
Diabetes	26
Food allergies	9
Other allergies	8
Gastrointestinal problems	26
High blood pressure/hypertension	26
High cholesterol	37
Heart disease	28
Lack of energy	38
Lactose intolerance	8
Memory loss	26
Menopause	9

(continued from Table 4.6)

Question	Respondent (%)
Nutrient deficiency	21
Obesity	36
Osteoporosis	19
Others	6
I am not concerned about any health conditions.	8
Health effects have you heard that ginseng has (Check all that apply)[§]	
Prevention/treatment of cancer	14
Prevention/treatment of diabetes	4
Prevention/treatment of high blood pressure/hypertension	11
Prevention/treatment of heart/cardiovascular diseases	10
Enhancement of memory	43
Improvement of stamina	37
Improvement of masculine strength	12
Improvement of mobility of reproductive tissues	7
Anti-oxidation	28
Anti-fatigue	44
Stress relief	27
Enhancement of immune system	32
Menopausal symptom relief	4
I have never heard about the health effects of ginseng.	18

[§] Respondents provided multiple answers, if relevant.

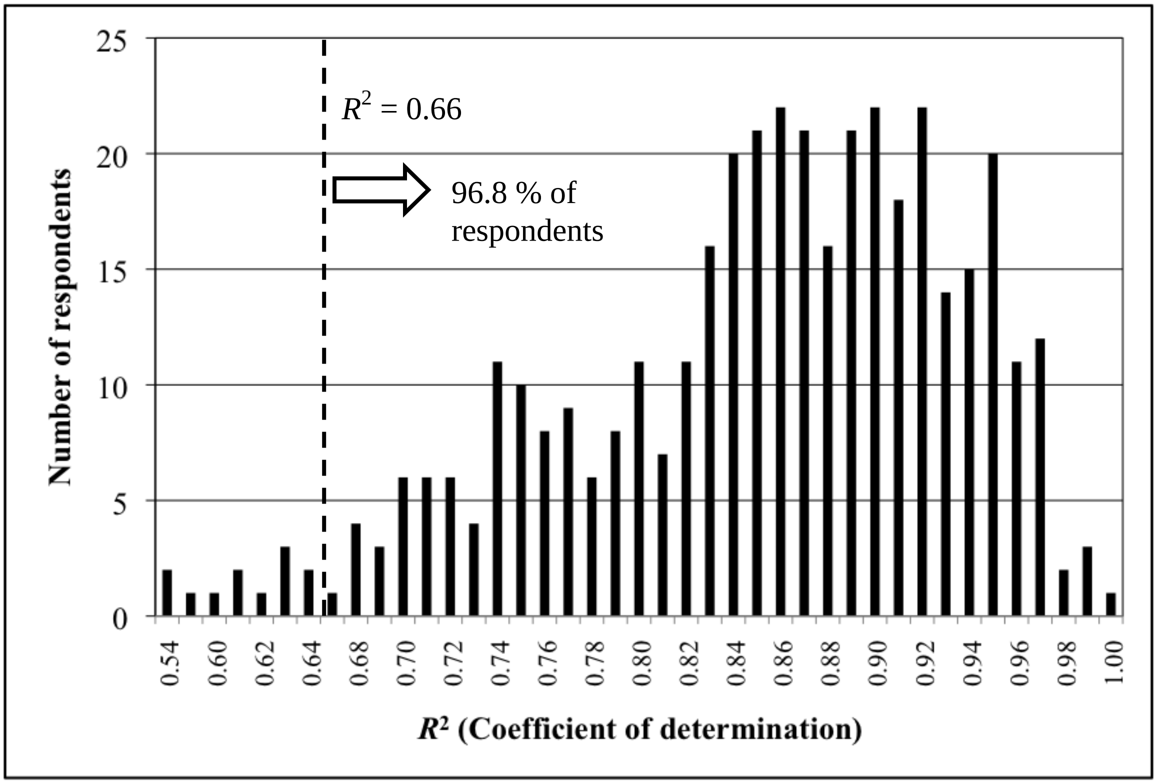

Figure 4.1. Consistency of respondents' reaction to conjoint elements. R^2, coefficient of determination, above 0.66, is considered for showing consistency in respondents' reactions. Dashed line is placed at R^2 = 0.66.

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CHAPTER 5. CONSUMER ACCEPTANCE OF GINSENG FOOD PRODUCTS

5.1. ABSTRACT

Ginseng is one of the most popular herbs used in dietary supplements. However, ginseng has not been widely utilized in food products in the United States. Sensory acceptance of ginseng food products by U.S. consumers has yet to be reported. The objectives of this study were to: 1) determine the sensory acceptance of commercial Korean red ginseng food products and 2) assess influence of the addition of sweeteners to ginseng tea and ginseng extract to chocolate on sensory acceptance through consumer acceptance testing. Seven commercial Korean red ginseng food products, 10 ginseng teas with sugar or honey sweeteners, and 10 ginseng milk or dark chocolates were evaluated by 126 consumers. All samples were evaluated for overall acceptance, followed by acceptance for appearance, aroma, texture, and taste, and purchase intent. The most accepted products were Korean red ginseng candy with vitamin C and Korean red ginseng crunchy white chocolate. Korean red ginseng root slices were the most unacceptable product. Cluster analysis segmented the consumers into three groups, which showed distinct preference patterns across 7 products. Sensory acceptance of ginseng tea was in proportion to sugar and honey content. Sensory acceptance of ginseng milk and dark chocolates was decreased with increasing ginseng extract contents, while ginseng milk chocolate was more acceptable to consumers than ginseng dark chocolate at the same levels of ginseng extract added. Findings demonstrate that ginseng products possessing sweet, fruity, and/or citrus flavors will have potential for success in the U.S. market and chocolate may be a food matrix into which ginseng can be incorporated, as containing more bioactive compounds than ginseng tea at a similar acceptance level. Future research may include a descriptive analysis with ginseng-based products to identify the key drivers of liking and disliking for successful new product development.

Key words: ginseng, tea, chocolate, acceptance, Korean red ginseng

5.2. INTRODUCTION

Functional foods have increased in popularity in recent years since the term 'functional foods' was first used in Japan in the 1980s (Hardy 2000; Siró and others 2008). Globally, total estimated sales of functional foods reached $75 billion in 2007 and was expected to grow to $109 billion by 2010 (Sloan 2008). In the United States, functional foods sales were $4.3 billion in 2004 and were forecasted to increase to $8.4 billion by 2014 (Mintel 2009). The increase in functional foods sales has been attributed to clinical evidence for functional ingredients elevating longevity, greater media coverage of health care issues, and health care cost containment (Goldberg 1999). However, improvement in sensory acceptance of functional foods is still the challenge to further increase functional food sales. Taste is one of the key factors that leads consumers to choose certain foods (Glanz and others 1998). However, undesirable flavors in most functional foods, including bitter, acrid, astringent, or salty off-flavors, which are naturally generated during enhancing food functionality with bioactive ingredients, decrease the sensory acceptance of those foods and eventually may discourage continued consumption (Tuorila and Cardello 2002; Siró and others 2008). Drewnowski and Gomez-Carneros (2000) pointed out that the competing demands between taste and health created a dilemma for the food industry. Previous research reported that consumers might not eat functional food products that are unacceptable in taste even if the products offer many health benefits (Gilbert 2000; Ares and others 2008; Barrios and others 2008).

Ginseng is one of the most popular medicinal herbs and has been used for over 2000 years in Asian countries (Lim and others 2005). Ginseng was ranked as one of the top-10-selling herbal dietary supplements in the United States from 2003 to 2007 (Mintel 2008). Health benefits of ginseng include growth inhibitory effects against tumor cells (Yun and Choi 1995; Duda and others 1996), immunomodulatory effects (Kenarova and others 1990; Kim and others 1990), anti-diabetic activities (Attele and others 1999; Xie and others 2005), and anti-fatigue effects (Saito and others 1974). Sensory properties of ginseng is characterized by earthy, woody, molasses, astringent, bitter, and sweet flavors (Kim and Sung 1985; Park and others 1999). The bitter tastes inherent in ginseng are considered as a factor, which detracts from consumers' interest as well as utilization of ginseng in food products. The peculiar bitterness has been attributed to ginsenosides, which are triterpenoid saponin glycosides unique to the genera *Panax*, because many saponins have been known to elicit bitterness. However, there has been little research elucidating the relationship of ginsenosides and their sensory properties. Furthermore, consumer sensory acceptance of ginseng food products has not been widely studied in the United States. In South Korea, red ginseng is widely used in various foods. Red ginseng roots are obtained by processing them with steaming and drying of white ginseng roots, which are processed by peeling the fresh ginseng roots and drying them without steaming (Kim and others 2002; Angelova and others 2008). Red ginseng roots are characterized by a reddish brown color and a glossy surface due to a non-enzymatic browning reaction. Red ginseng roots have been also known to have more fragrant, more roasted, and less earthy flavors, and sweeter than white ginseng (Lee and others 2005; Cho and others 2008). Six-year-old ginseng roots are generally used for red ginseng processing owing to their highest quality both in pharmacological effects and exterior shape (Koo and others 2005).

Utilization of ginseng in food products has been largely limited to functional beverages and energy drinks in the United States. Results from a survey of U.S. consumers conducted in 2009 show that only 9 % of consumers looked for functional foods containing ginseng in the market. Meanwhile, 54 % of consumers responded that they had neutral opinions about ginseng, but ginseng was not the main reason why they sought the functional foods (Mintel 2009). Such statistical data imply that ginseng does not much attract the interest of consumers as an ingredient for functional food products, despite its numerous health benefits. On the other hand, people in Asian countries are exposed to various ginseng food products, such as ginseng concentrate, candies, chocolates, chewing gums, jellies, root slices preserved with honey, and cookies, as well as drinks and teas (Yang 1996).

The preceding focus groups identified that most consumers had little knowledge of ginseng and related food products (Chung 2010a). The participants suggested that sweeteners, including sugar or honey, would improve sensory characteristics of ginseng food products as to mask bitter and earthy flavors of ginseng. In the preceding conjoint analysis study, ginseng food product concepts including “sweetness” element attracted the interest of consumers, and ginseng chocolate was identified as a potential ginseng food product type to be successful in the U.S. market (Chung 2010b). The objectives of this study were to: 1) determine the sensory acceptance level of commercial Korean red ginseng food products among U.S. consumers and 2) examine effects of sweeteners on sensory acceptance of ginseng tea and ginseng extracts on sensory acceptance of chocolates through consumer acceptance testing.

5.3. MATERIALS AND METHODS

Sample Preparation

Commercial Korean Red Ginseng Food Products

Seven commercial Korean red ginseng food products were used for the consumer acceptance test. The ginseng products, manufacturers, and ingredients are listed in Table 5.1. Korean red ginseng root slices preserved with honey, ginseng jelly, ginseng hard candy, ginseng crunchy white chocolate, and ginseng candy with vitamin C were taken out from individual packaging and served in 59-mL of plastic containers (Solo Cup Co., Urbana, IL, USA), labeled with a 3-digit random number including lids. Korean red ginseng extract tea was prepared by dissolving 0.5 g of the extract per 100 mL of hot water (Absopure, Urbana, IL, USA) and cooling to room temperature (~22 ℃). Korean red ginseng granular tea was made by adding 1 pack of granule (3 g) per 200 mL of hot water, then cooling to room temperature (~22 ℃). The preparation of ginseng tea samples followed directions shown on the packaging. Approximately 20 mL of the ginseng tea was presented to panelists in 59-mL plastic containers, labeled with a 3-digit random number, including lids.

Preparation of Laboratory-developed Ginseng Tea and Ginseng Chocolate

Ginseng tea was prepared by dissolving 0.5 g of Korean red ginseng extract (Choongbook agricultural cooperative, Jeungpyung, Korea) per 100 mL of hot water. Two different sweeteners, sugar and honey, were added to the ginseng tea. Granulated sugar (C&H Sugar Company, Inc., Crockett, CA, USA) was added to the ginseng tea at levels of 1, 3, 6, 9, and 12 g per 100 mL of ginseng tea. Honey (Sue Bee Honey Associate, Sioux City, IA, USA) was dissolved in the ginseng tea at levels of 3, 6, 9, 12, and 15 g per 100 mL of ginseng tea. Approximately 20 mL of the sweetened ginseng tea was presented to consumers in 59-mL plastic containers labeled with a 3-digit random number, including lids.

Ginseng chocolates were made with two different chocolate bases: milk chocolate and dark chocolate (Wilton Industries, Woodridge, IL, USA). Ginseng extract powder (*Panax ginseng*, 80 % ginsenosides, Amax NutraSource, Eugene, OR, USA) was added to milk chocolate and dark chocolate at levels of 0, 0.1, 0.2, 0.4 and 0.6 g per 100 g of each chocolate. The mixtures of chocolate and ginseng extract powder were fully melted in a microwave oven (Model R-308JW, 120 VAC, 60Hz, Sharp Electronic Corp., Mahwah, NJ, USA) for 1 to 2 min and then molded into approximately 2 g of a cone-shape. Two cone-shaped ginseng chocolates were served in 59-mL plastic containers labeled with a 3-digit random number with lids.

Subjects

One hundred twenty-six consumers (34 males, 92 females, 18 to 68 years of age) participated in the study. Consumers were recruited via email invitations and flyers distributed within the University of Illinois at Urbana-Champaign community. Prior to participation, consumers were screened through the use of a pre-screening questionnaire, which asked about food allergies, time availability, and nationality. Koreans and Chinese, who generally have more consumption experiences with ginseng foods, were excluded from participation because this study aimed at examining acceptance levels of ginseng food products for people who have less exposure to ginseng foods. Consumers who had no allergies to the ingredients contained in the sample products were invited to attend three independent sessions with 1) commercial Korean red ginseng food products, 2) ginseng teas varying in sugar and honey level, and 3) milk and dark chocolates with varying ginseng extract content. Consumers were asked to complete a demographic questionnaire at the end of the third session. Demographic profile of consumers is shown in Table 5.2.

Consumer Acceptance Test Procedure

Commercial Korean red ginseng food products, ginseng teas, and ginseng chocolates were evaluated in three individual sessions conducted on separate days. Prior to each session, consumers were given instructions regarding evaluation procedure and rinsing protocol, and completed an informed consent form approved by the University of Illinois Institutional Review Board. Consumers evaluated a total of 7 commercial Korean red ginseng food products in the first session. In the second session, a total of 10 ginseng tea samples were evaluated. The first sixty-three consumers tasted 5 ginseng teas with sugar, followed by 5 ginseng teas with honey. The last sixty-three consumers tasted the same ginseng teas in reverse order. Consumers had a 3-minute break after testing the first 5 samples in order to prevent fatigue due to the large number of samples within one session. Five ginseng milk chocolates and 5 ginseng dark chocolates, which varied in content of ginseng extract, were evaluated in the third session. Similarly to the ginseng tea evaluation, half of the consumers tasted 5 milk chocolates, followed by a 3-minute break and then 5 dark chocolates; the other half of the consumers then tasted 10 ginseng chocolates in reverse order.

All samples within each session were presented to consumers monadically in a balanced order based on the mutually orthogonal latin squares (MOLS) design, which is balanced for *k*-1 carryover effects, where *k* is the number of samples presented to each subject (Wakeling and MacFie 1995). Consumers evaluated all samples for overall acceptance, followed by acceptance of appearance, aroma, texture, and taste, using a modified 9-point hedonic scale with end anchors, “1 = extremely dislike” to “9 = extremely like”. Consumers also rated purchase intent for the samples using a 5-point scale with end anchors, “1 = definitely will not buy” to “5 = definitely will buy”. Consumers were instructed to expectorate all samples and rinse with carbonated water (Cadbury Schweppes, Plano, TX, USA), followed by spring water before the first sample and between samples. Each session lasted about 20 to 30 minutes and was conducted in individual booths using the Compusense® *five* data acquisition system (version 4.8, Guelph, Ontario, Canada) under incandescent lighting.

Statistical Analyses

Ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent of each sample were analyzed by analysis of variance (ANOVA) and then Fisher's least significant difference (LSD) procedure with Statistical Analysis Software (SAS, version 9.2, SAS Institute, Inc., Cary, NC, USA). Internal preference mapping of 7 commercial Korean red ginseng food products was performed by principal component analysis (PCA) on the covariance matrix of mean scores of overall acceptance according to Greenhoff and MacFie (1994) by using SAS (version 9.2). An agglomerative hierarchical cluster analysis was conducted on overall acceptance ratings by the Euclidean distance for the dissimilarity scale by the Ward's method with XLSTAT (version 2009, Addinsoft, New York, NY, USA).

5.4. RESULTS AND DISCUSSION

Sensory Acceptance of Commercial Korean Red Ginseng Food Products

The mean scores of 126 consumers' ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent for 7 commercial Korean red ginseng food products are shown in Table 5.3. For overall acceptance, Korean red ginseng candy with vitamin C scored the highest (7.1), but was not significantly different from Korean red ginseng crunchy white chocolate (6.8) in the mean score. The ginseng candy with vitamin C was also rated highest for acceptance of aroma (6.9) and taste (7.4). The ginseng crunchy white chocolate had the highest scores in acceptance of appearance (7.0) and texture (7.3). Meanwhile, Korean red ginseng root slices preserved with honey received the lowest score (3.1) in overall acceptance, followed by Korean red ginseng extract tea (3.6). The ginseng root slices were also evaluated as the least acceptable products for all four attributes—in particular, they received 2.6 for acceptance of taste. The ginseng extract tea was also one of the unacceptable products for all four attributes among 7 commercial ginseng products examined in this study. Korean red ginseng granular tea, Korean red ginseng jelly, and Korean red ginseng hard candy received neutral ratings on the 9-point hedonic scale, ranging from 4.0 for acceptance of taste of the ginseng granular tea to 6.3 for acceptance of appearance and texture of the ginseng hard candy. In regard to purchase intent, the ginseng crunchy white chocolate (3.8) and the ginseng candy with vitamin C (3.7) were identified as the products with the highest scores. However, the other ginseng products were rated below 2.4. This suggests that ginseng products similar to the ginseng crunchy white chocolate and the ginseng candy with vitamin C will have potential for success in the U.S. market.

An internal preference map generated with mean ratings of overall acceptance of products is shown in Figure 5.1. The first two principal components (PCs) explained a total of 67.4 % of the variance. PC 1 and PC 2 accounted for 52.9 % and 14.5 %, respectively. Consumers were mostly aggregated in the direction of the ginseng crunchy white chocolate and the ginseng candy with vitamin C, indicating that most consumers liked these two ginseng products. On the other hand, the map showed that consumers most disliked the ginseng extract tea and the ginseng root slices.

These results quantitatively confirmed the findings from the preceding focus groups, namely, that the ginseng candy with vitamin C was the most acceptable to panelists that participated in the focus groups and would attract interest of U.S. consumers (Chung 2010a). Panelists who participated in the focus groups also stated that fruity and citrus flavors in the ginseng candy with vitamin C might effectively mask objectionable ginseng flavors and eventually increase sensory acceptance of the ginseng products. In purchasing functional foods, familiarity with the functional ingredients and the product type is another important factor—equally as important as taste—to consumers (Urala and Lahteenmaki 2003). The ginseng candy with vitamin C—which is a similar product type as the vitamin tablets for kids—and the ginseng crunchy white chocolate—which is an individually wrapped chocolate—were familiar product types to the participants. For the same reasons, the lowest acceptance rating of the ginseng root slices was expected because the preceding focus group panel compared the ginseng root slices to dried potatoes or carrots in appearance and described them to be too sticky in texture and too strong in ginseng flavor. Findings from this study suggested that new ginseng food products, which will be highly acceptable to U.S. consumers, be similar to product types with which they may already be familiar. Moreover, results from the consumer test indicate that new ginseng food products should be improved from the original ginseng tastes by adding sweeteners and additional flavors such as fruity and citrus flavors. Taste is a key factor for consumers' decision on purchasing functional food products because consumers do not renounce taste in functional foods for health benefits which the foods provide (Tuorila and Cardello 2002; Verbeke 2006).

Segmentation of Consumers by Cluster Analysis

An agglomerative hierarchical cluster analysis divided 126 consumers into three groups. Mean scores of overall acceptance ratings of the three groups across 7 ginseng products are found in Table 5.4. Each group showed distinct preference patterns across 7 products. Group A (n = 48), which consisted of the largest number of consumers among three groups, evaluated all products with relatively even scores when compared to the other two groups. Only the ginseng root slices and the extract tea received ratings below 5 point (neither like nor dislike). The ginseng crunchy white chocolate (7.4) received the highest score of overall acceptance but was not significantly different from the ginseng candy with vitamin C (6.8) and the ginseng hard candy (6.7) when assessed by Group A. The ginseng root slices were assessed as the least acceptable product among the 7 ginseng products by Group A. Group B (n = 41) was characterized as having a lower acceptance level for most ginseng products than the other two groups. In particular, mean ratings of overall acceptance of the ginseng root slices, the ginseng extract tea, the ginseng jelly, and the ginseng granular tea ranged from 1.7 to 2.8. Consumers in Group B distinctly preferred the ginseng candy with vitamin C (6.9) to the ginseng crunchy white chocolate (5.3). Group C (n = 37) rated the ginseng candy with vitamin C (7.8) and the ginseng crunchy white chocolate (7.8) relatively higher in overall acceptance than the other two groups. Mean ratings of overall acceptance of the other five ginseng products by Group C were between the mean ratings by Group A and Group B.

Effects of Sweetener Contents on Sensory Acceptance of Ginseng Tea

Mean ratings of acceptance and purchase intent of ginseng teas that differ in sugar content are shown in Table 5.5. Acceptance and purchase intent ratings for ginseng tea containing no sugar were obtained from the results of the first session, in which commercial Korean red ginseng products were evaluated, because the ginseng teas were prepared with the same commercial products and in the same manner. Overall acceptance, acceptance of four attributes, and purchase intent of ginseng tea increased with sugar content. Overall acceptance, acceptance of taste, and purchase intent were most positively influenced by sugar content. Meanwhile, acceptance of appearance, aroma, and texture were relatively less affected by the addition of sugar to ginseng tea. Ginseng tea containing 12 g of sugar per 100 mL had the highest scores in the overall acceptance (5.7), acceptance of aroma (5.4) and taste (5.7), and purchase intent (2.9), but was not significantly different from ginseng tea containing 9 g of sugar per 100 mL in those acceptance attributes and purchase intent. Therefore, 9 g of sugar per 100 mL of ginseng tea would be an effective level that would result in high acceptance.

Table 5.6 shows mean ratings of acceptance and purchase intent of ginseng tea with varying honey content as well as the mean ratings for ginseng tea without honey, which were obtained from the first session with commercial Korean red ginseng products. Overall acceptance, acceptance of four attributes, and purchase intent of ginseng tea increased in proportion to honey content. Mean ratings of overall acceptance, and acceptance of aroma, texture, and taste of ginseng tea with honey were not significantly different among 9, 12, and 15 g of honey per 100 mL. Ginseng tea containing 12 g of honey per 100 mL (2.9) rated the highest in purchase intent but had no significant difference from ginseng tea containing 15 g of honey per 100 mL (2.8) in purchase intent. Mean acceptance ratings of appearance were least influenced by adding honey to ginseng tea. When both acceptance ratings and purchase intent ratings were considered, 12 g of honey per 100 mL of ginseng tea was the level at which consumers had the highest acceptance.

Ginseng tea was used as a matrix to investigate effects of sweeteners on ginseng products because ginseng tea was shown to be a familiar ginseng product with consumers based on the previous studies (Chung 2010a). Commercial Korean red ginseng extract which was used as the base for preparation of ginseng tea did not include any additional ingredients. In comparison between ginseng tea containing two different sweeteners, acceptance ratings of ginseng tea with sugar were not noticeably different from those with ginseng tea containing honey. The highest overall acceptance ratings were 5.7 for 9 g of sugar per 100 mL of ginseng tea, and 5.5 for 12 g and 15 g of honey per 100 mL of ginseng tea. Meanwhile, aroma acceptance was rated slightly higher in ginseng tea with honey than ginseng tea with sugar. This agreed with a finding from the preceding focus group, indicating that panelists preferred honey to sugar as a sweetener for masking bitterness in ginseng products (Chung 2010a). The highest overall acceptance level of ginseng tea with sugar or honey, which was 5.7 or 5.5, was relatively lower than the level of Korean red ginseng candy with vitamin C or Korean red ginseng crunchy white chocolate, which was 7.1 or 6.8, respectively. This illustrates that the ginseng tea increases in the acceptance level when a sweetener is added, but there is room for improvement in other sensory attributes. An alternative way to increase the acceptance level may be adding citrus or fruity flavors, as suggested by the preceding focus group and conjoint analysis (Chung 2010a, b).

Effects of Ginseng Extract Contents on Acceptance of Milk and Dark Chocolates

Mean ratings of overall acceptance, acceptance of four attributes, and purchase intent of milk chocolate with varying ginseng extract levels are found in Table 5.7. Addition of ginseng extract to milk chocolate decreased the acceptance of all attributes and purchase intent. In particular, mean ratings of overall acceptance, acceptance of taste, and purchase intent ratings sharply decreased with the addition of ginseng extract. Milk chocolate without ginseng extract received 7.6 for overall acceptance, which decreased to 4.0 for the milk chocolate containing 0.4 g of ginseng extract per 100 g. Only milk chocolates containing 0.1 and 0.2 g of ginseng extract per 100 g received above 5 point for overall acceptance and above 2.5 point for purchase intent, which are neutral points on the 9-point hedonic scale and the 5-point purchase intent scale, respectively. Therefore, milk chocolate containing 0.4 g and above of ginseng extract per 100 g was considered to be not acceptable to U.S. consumers.

Table 5.8 shows the mean ratings of acceptance and purchase intent for dark chocolate with varying ginseng extract content. The addition of ginseng extract to dark chocolate had a negative effect on acceptance and purchase intent. The ginseng dark chocolate containing 0.1 and 0.2 g of ginseng extract per 100 g received 6.1 and 5.3 for overall acceptance, respectively, while the dark chocolate containing no ginseng extract scored 7.0 for overall acceptance. The ginseng dark chocolate containing 0.4 g of ginseng extract per 100 g received 3.9 for overall acceptance and 1.7 for purchase intent. This indicates that ginseng dark chocolate containing ginseng extract in the amount of 0.4 g and above per 100 g chocolate may be unacceptable to U.S. consumers.

Milk chocolates scored slightly higher than dark chocolates at the same levels of ginseng extract in the overall acceptance. Milk chocolate and dark chocolate containing no ginseng extract received 7.6 and 7.0 for overall acceptance, respectively. Overall acceptance ratings of milk chocolate with ginseng extract added ranged from 4.0 to 6.3, and overall acceptance ratings of dark chocolate with ginseng extract added scored from 3.3 to 6.1. This indicates that consumers slightly prefered milk chocolate to dark chocolate, whether or not the chocolate contained ginseng extract. This might be due to the additional sweetness of milk chocolate. As shown in ginseng tea with sugar or honey, sweetness increased acceptance levels of the products.

The ginseng extract incorporated into the chocolates was labeled as containing 80 % ginsenosides. High performance liquid chromatography (HPLC) analysis, which was conducted to profile ginsenosides in the ginseng extract, determined that the ginseng extract contained 62.5 % of ginsenosides, based on 12 most abundant ginsenosides (Chung 2010c). Ginseng has been reported to contain 0.7 to 20 % ginsenosides in dried ginseng roots form (Attele and others 1999; Corthout and others 1999). Therefore, the ginseng extract used in the study was highly concentrated in terms of its ginsenoside content. Based on the ginsenoside content of the ginseng extract by HPLC analysis, milk or dark chocolate prepared at the level of 0.2 g of ginseng extract per 100 g of chocolate, which scored 5.5 or 5.3 for overall acceptance, could be estimated as containing approximately 0.13 g of ginsenosides/100 g of chocolate. When one serving size of chocolates is usually considered approximately 40 g, the ginseng milk or dark chocolate contains approximately 0.05 g of ginsenosides per serving. Although the Korean red ginseng extract used for ginseng tea preparation in this study did not provide ginsenoside content on its packaging, Choi and others (1989) reported that a commercial ginseng extract product, which was considered similar to the ginseng extract used in this study, contained 3.88 g of ginsenosides/100 g of the extract. Therefore, the ginseng tea used in this study, which were prepared by dissolving 0.5 g of the ginseng extract per 100 mL of water, could be estimated as containing approximately 0.02 g of ginsenosides/100 mL of ginseng tea. Therefore, 200 mL of ginseng tea, which is considered one serving size, contains 0.04 g of ginsenosides. When the highest overall acceptance rating was 5.7 or 5.5 for ginseng tea with sugar or honey, it could be concluded that ginseng chocolates containing 0.2 g of ginseng extract per 100 g constitute a product that contains more bioactive compounds and at the same time could deliver similar acceptance level. These findings demonstrate that improvement in sensory acceptance of ginseng food products can be accomplished by utilizing chocolate as a matrix for a new ginseng food product, which further suggests that additional ingredients may not be necessary in ginseng food product to enhance sensory acceptance. This will attract interest of certain consumers who are not delighted with additional sweeteners or flavoring agents.

Previous clinical studies reported that people who were given 0.2 g of standardized *Panax ginseng* extracts (equivalent with 0.008 g of ginsenosides) daily for 4 or 9 weeks were improved in mental arithmetic ability (D'angelo and others 1986) and physical performance (Forgo 1983; Forgo and Schimert 1985; Vogler and others 1999) and were enhanced in immunomodulatory activities (Scaglione and others 1990). Moreover, Sotaniemi (1995) reported that oral administration of 0.2 g of ginseng extract per day reduced fasting blood glucose, which means that ginseng extract was effective in the management of non-insulin-dependent diabetes mellitus. Therefore, regular consumption of the ginseng tea including approximately 0.04 g of ginsenosides per serving or the ginseng chocolate containing approximately 0.05 g of ginsenosides per serving are expected to provide positive health effects. Future studies may be conducted to examine the exact ginsenoside content of ginseng products used in this study because the content of ginsenosides in ginseng roots or ginseng extracts varies depending on many factors, including part and age of the ginseng roots used, as well as manufacturers, processing methods, and product type (liquid or powder) (Cui 1995; Court and others 1996; Li and Wang 1998; Corthout and others 1999; Li and Mazza 1999; Harkey and others 2001; Assinewe and others 2003). Total ginsenoside content is considered a standard to measure potency of ginseng products (Schlag and McIntosh 2006). Although some commercial ginseng products sold in the United States list total ginsenosides content on the package label, such claims may be inaccurate because there is no regulation to supervise them to date (Hall and others 2001; Schlag and McIntosh 2006).

Therefore, these findings suggest that ginsenoside content should be clearly stated on the package of ginseng products, which should be regulated by an appropriate agency such as FDA.

5.5. CONCLUSIONS

The findings of this study have demonstrated that products similar to ginseng candy with vitamin C and ginseng crunchy white chocolate will have market potential in the United States. Those particular ginseng products were relatively more familiar product types to U.S. consumers than ginseng root slices or ginseng granular tea, and contained additional flavors such as sweet, fruity, or citrus flavors. Addition of sugar or honey to ginseng tea increased consumers' acceptance levels. The acceptance levels for milk and dark chocolates decreased with increasing ginseng extract content. However, chocolate was identified as a food matrix for a potential ginseng product, which contained more ginsenosides than sweetened ginseng tea, and had similar acceptance levels. Future research into sensory profiles of ginseng-based products by a descriptive analysis will benefit the industry by identifying the key drivers of liking and disliking for these products in order to achieve successful new product development.

5.6. TABLES AND FIGURES

Table 5.1. Commercial Korean red ginseng food products used for the consumer acceptance test

Product name	Manufacturer	Ingredient§
Korean red ginseng extract tea	Choongbook Agricultural Cooperative (Jeungpyung, Korea)	Korean red ginseng (6-year-old) extract 100 %
Korean red ginseng granular tea	Choongbook Agricultural Cooperative	Korean red ginseng (6-year-old) extract 10 %, glucose, lactose, vitamin C
Korean red ginseng root slices preserved with honey	Choongbook Agricultural Cooperative	Korean red ginseng (6-year-old) (51 %), honey, isomalto-oligosaccharides, fructose
Korean red ginseng crunchy white chocolate	Hansamin (Seoul, Korea)	Korean red ginseng (6-year-old) extract 1.2 %, sucrose, milk, cocoa butter, palm oil, wheat flour, corn starch, vanilla, lecithin, red ginseng flavor
Korean red ginseng jelly	Kumsan Ginseng Cooperative (Kumsan, Korea)	Sucrose, oligosaccharides, agar, Korean red ginseng (6-year-old) extract (1.0 %), herbal flavors, L-menthol
Korean red ginseng hard candy	Hansamin	Korean red ginseng (6-year-old) extract 1.2 %, sucrose, corn syrup, isomalto-oligosaccharide, xylitol, red ginseng flavor, L-menthol
Korean red ginseng candy with vitamin C	Hansamin	Korean red ginseng (6-year-old) powder 2 %, glucose, citrate, dextrin, magnesium stearate, aspartame, vitamin C, natural colors

§ From ingredient information shown on packaging.

Table 5.2. Demographic profile of consumers (*n* = 126)

Question	Answer	Consumer (%)
Age	< 18	0
	18–25	53
	26–35	19
	36–45	11
	46–55	12
	56–65	3
	> 66	2
Gender	Male	27
	Female	73
Marital status	Single	70
	Married	30
Races	American Indian or Alaska Native	1
	Asian	17
	Black or African-American	2
	Caucasian	75
	Hispanic or Latino	3
	Native Hawaiian or other Pacific Islander	1
	Not applicable	2
Education level	Some high school	0
	High school graduate	6
	Technical school	0
	Some college	33
	Bachelor's degree	24
	Post-graduate degree	37
Income level	< $25,000	33
	$25,000–$34,999	6
	$35,000–$49,999	13
	$50,000–$74,999	18
	$75,000–$99,999	14
	> $100,000	16
Consumption frequency	Every day	0
	Several times a week	3
	Several times a month	6
	Once a month	6
	Several times a year	37
	Once a year	21
	Never	28

Table 5.3. Mean scores of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent for seven commercial Korean red ginseng food products

	Root slices§	Extract tea	Granular tea	Jelly	Hard candy	Candy w/ vit C	Chocolate
Overall acceptance†	3.1e	3.6d	4.2c	4.5bc	4.7b	7.1a	6.8a
Appearance	3.7d	5.1c	5.3c	6.1b	6.3b	5.9b	7.0a
Aroma	4.0f	4.6de	5.0cd	4.5e	5.4c	6.9a	6.4b
Texture	4.1e	5.7d	6.0cd	5.7d	6.3bc	6.5b	7.3a
Taste	2.6c	2.9c	4.0b	4.1b	4.4b	7.4a	7.0a
Purchase intent	1.5d	1.7d	2.0c	2.2bc	2.4b	3.7a	3.8a

§ Means with the same letters in a row are not significantly different ($p < 0.05$).
† Overall acceptance, acceptance of appearance, aroma, texture, and taste were rated on a 9-point hedonic scale, "1 = extremely dislike" to "9 = extremely like". Purchase intent was rated on a 5-point scale, "1 = definitely will not buy" to "5 = definitely will buy".

Table 5.4. Mean scores of overall acceptance ratings of three consumer clusters by cluster analysis for 7 commercial Korean red ginseng food products

	Root slices§	Extract tea	Granular tea	Jelly	Hard candy	Candy w/ vit C	Chocolate
Group A (n = 48)†	3.8d	4.7c	5.4c	6.6b	6.7ab	6.8ab	7.4a
Group B (n = 41)	1.7d	2.4c	2.8c	2.8c	2.5c	6.9a	5.3b
Group C (n = 37)	3.6d	3.3d	4.4bc	3.7cd	4.4b	7.8a	7.8a

§ Means with the same letters in a row are not significantly different ($p < 0.05$).
† Overall acceptance was rated on a 9-point hedonic scale, "1 = extremely dislike" to "9 = extremely like".

Table 5.5. Mean ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent of ginseng tea varying in sugar levels

	Sugar content [per 100 mL of ginseng tea]					
	0 g[§]	1 g	3 g	6 g	9 g	12 g
Overall acceptance[†]	3.6[d]	3.9[d]	4.7[c]	5.2[b]	5.6[ab]	5.7[a]
Appearance	5.1[c]	5.7[b]	5.9[ab]	5.9[ab]	6.1[a]	6.1[a]
Aroma	4.6[d]	4.8[cd]	5.0[bc]	5.4[a]	5.3[ab]	5.4[a]
Texture	5.7[abc]	5.4[c]	5.6[bc]	5.9[ab]	6.0[a]	6.0[a]
Taste	2.9[e]	3.4[d]	4.4[c]	5.2[b]	5.6[a]	5.7[a]
Purchase intent	1.7[d]	1.8[d]	2.2[c]	2.7[b]	2.8[ab]	2.9[a]

[§] Means with the same letters in a row are not significantly different ($p < 0.05$).
[†] Overall acceptance, acceptance of appearance, aroma, texture, and taste were rated on a 9-point hedonic scale, "1 = extremely dislike" to "9 = extremely like". Purchase intent was rated on a 5-point scale, "1 = definitely will not buy" to "5 = definitely will buy".

Table 5.6. Mean ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent of ginseng tea varying in honey levels

	Honey content [per 100 mL of ginseng tea]					
	0 g[§]	3 g	6 g	9 g	12 g	15 g
Overall acceptance[†]	3.6[d]	4.2[c]	5.0[b]	5.4[a]	5.5[a]	5.5[a]
Appearance	5.1[b]	5.9[a]	5.9[a]	6.1[a]	6.1[a]	6.1[a]
Aroma	4.6[d]	5.0[c]	5.4[b]	5.5[ab]	5.7[a]	5.7[ab]
Texture	5.7[ab]	5.3[c]	5.6[bc]	5.8[ab]	5.9[a]	6.0[a]
Taste	2.9[d]	3.9[c]	4.5[b]	5.0[a]	5.5[a]	5.4[a]
Purchase intent	1.7[e]	2.0[d]	2.3[c]	2.7[b]	2.9[a]	2.8[ab]

[§] Means with the same letters in a row are not significantly different ($p < 0.05$).
[†] Overall acceptance, acceptance of appearance, aroma, texture, and taste were rated on a 9-point hedonic scale, "1 = extremely dislike" to "9 = extremely like". Purchase intent was rated on a 5-point scale, "1 = definitely will not buy" to "5 = definitely will buy".

Table 5.7. Mean ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent of ginseng milk chocolate varying in ginseng extract levels

	Ginseng extract content [per 100 g of milk chocolate]				
	0 g[§]	0.1 g	0.2 g	0.4 g	0.6 g
Overall acceptance[†]	7.6^{a}	6.3^{b}	5.5^{c}	4.0^{d}	4.2^{d}
Appearance	7.4^{a}	7.2^{ab}	7.0^{bc}	6.9^{c}	6.8^{c}
Aroma	7.4^{a}	7.2^{a}	6.9^{b}	6.9^{b}	6.6^{c}
Texture	7.5^{a}	7.3^{b}	7.1^{c}	6.9^{c}	7.0^{c}
Taste	7.6^{a}	6.0^{b}	4.9^{c}	2.8^{e}	3.3^{d}
Purchase intent	4.2^{a}	3.4^{b}	2.7^{c}	1.7^{d}	2.0^{e}

[§] Means with the same letters in a row are not significantly different ($p < 0.05$).
[†] Overall acceptance, acceptance of appearance, aroma, texture, and taste were rated on a 9-point hedonic scale, “1 = extremely dislike” to “9 = extremely like”. Purchase intent was rated on a 5-point scale, “1 = definitely will not buy” to “5 = definitely will buy”.

Table 5.8. Mean ratings of overall acceptance, acceptance of appearance, aroma, texture, and taste, and purchase intent of ginseng dark chocolate varying in ginseng extract levels

	Ginseng extract content [per 100 g of dark chocolate]				
	0 g[§]	0.1 g	0.2 g	0.4 g	0.6 g
Overall acceptance[†]	7.0^{a}	6.1^{b}	5.3^{c}	3.9^{d}	3.3^{e}
Appearance	7.3^{a}	7.0^{b}	6.5^{c}	6.2^{d}	6.4^{c}
Aroma	6.7^{a}	6.3^{b}	5.9^{c}	5.7^{cd}	5.6^{d}
Texture	7.4^{a}	7.1^{b}	6.8^{c}	6.5^{d}	6.6^{cd}
Taste	7.1^{a}	5.8^{b}	4.8^{c}	3.1^{d}	2.4^{e}
Purchase intent	4.0^{a}	3.2^{b}	2.7^{c}	1.7^{d}	1.6^{d}

[§] Means with the same letters in a row are not significantly different ($p < 0.05$).
[†] Overall acceptance, acceptance of appearance, aroma, texture, and taste were rated on a 9-point hedonic scale, “1 = extremely dislike” to “9 = extremely like”. Purchase intent was rated on a 5-point scale, “1 = definitely will not buy” to “5 = definitely will buy”.

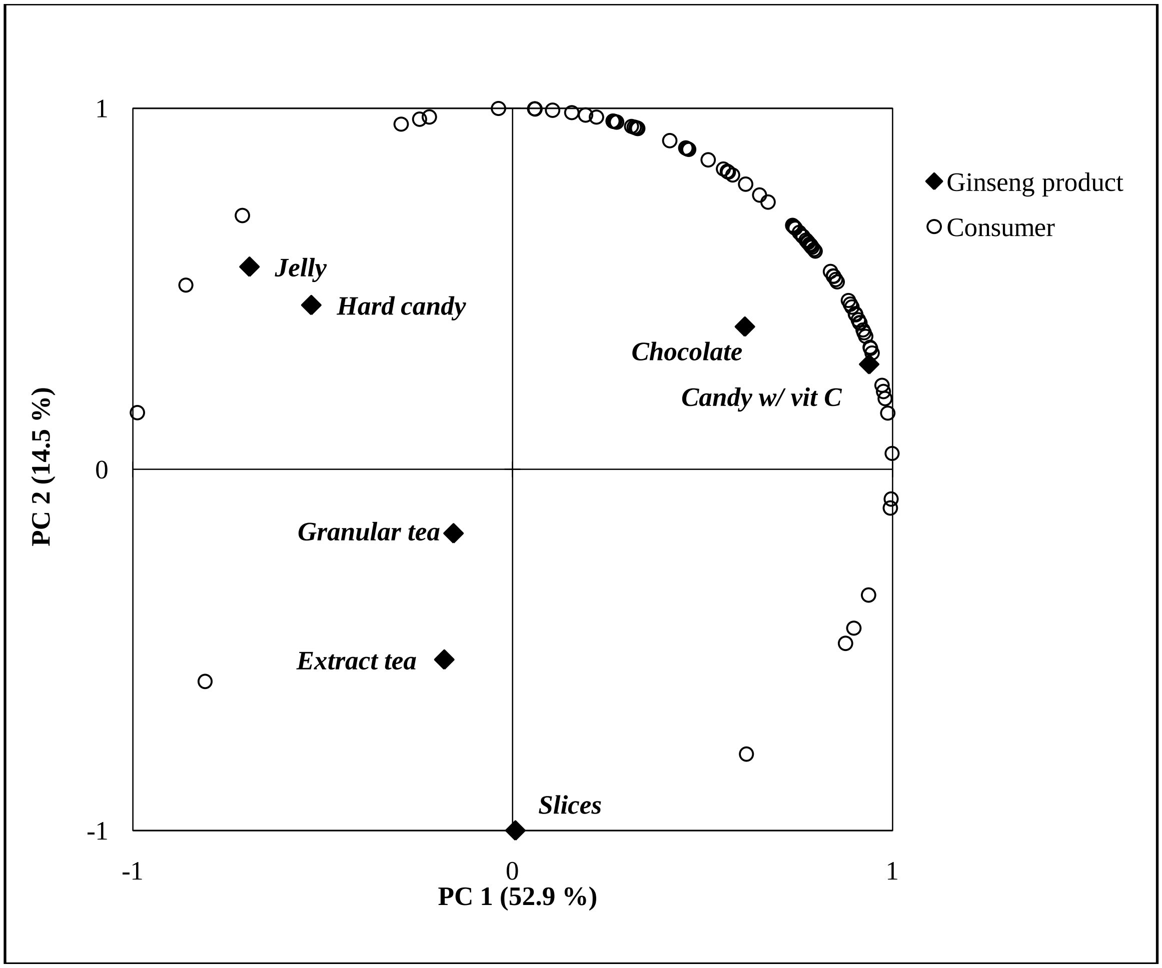

Figure 5.1. Internal preference map for overall acceptance of commercial Korean red ginseng food products. Principal component analysis was conducted on the covariance matrix and the biplot was rotated with the varimax method.

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CHAPTER 6. MASKING EFFECTS OF CHOCOLATE BITTERNESS ON GINSENG TASTES

6.1. ABSTRACT

Ginseng is not widely accepted by U.S. consumers due to its peculiar tastes, despite its numerous health benefits. Previous studies have suggested that the bitter compounds in chocolate and coffee may mask ginseng bitterness. The objectives of this study were to: 1) profile sensory characteristics of ginseng extract, caffeine, cyclo (L-Pro-L-Val), theobromine, and two model solutions simulating chocolate bitterness and 2) determine the changes in the sensory characteristics of the bitter compounds found in coffee and chocolate by the addition of ginseng extract. Thirteen solutions were prepared in concentrations similar to the bitter compounds found in coffee and chocolate products. Twelve panelists participated in a descriptive analysis panel which included time-intensity (TI) ratings. Alcohol bitterness, coffee bitterness, cocoa bitterness, grapefruit pith bitterness, medicinal bitterness, sweetness, sourness, green tea, astringency, and starchiness were attributes significantly different across sample solutions ($p < 0.05$). Ginseng extract solution was characterized as sweeter, starchier, and more green tea than the other sample solutions. The addition of ginseng extract increased alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness of caffeine, cyclo (L-Pro-L-Val), and theobromine solutions, as well as a model solution simulating milk chocolate bitterness. Another model solution, which simulated dark chocolate bitterness, increased only in medicinal bitterness by the addition of ginseng extract. The addition of ginseng extract mainly increased intensities of bitterness in caffeine and cyclo (L-Pro-L-Val) solutions and duration time in bitterness of the two model solutions. Dark chocolate could be proposed as the product in which to incorporate ginseng with minimal changes in the sensory characteristics. Future studies blending aroma compounds of chocolate and coffee into such model solutions may be conducted to investigate the influence on the perception of bitterness through congruent flavors of chocolate and coffee.

Key words: ginseng, bitterness, chocolate, coffee, time-intensity rating

6.2. INTRODUCTION

Bitterness is a taste sensation commonly found in vegetables, fruits, and tree nuts such as broccoli, cauliflower, soybeans, lemon, grapefruit, green tea, red wine, coffee beans, cocoa beans, almonds, and walnuts (Drewnowski and Gomez-Carneros 2000). The compounds responsible for bitterness in these foods have been identified as amines, amino acids, alkaloids, flavonoids, and terpenoids (Meyerhof and others 2009). Acceptance of bitterness depends on many factors such as genetic differences, dietary experience, and age (Schiffman and others 1994; Drewnowski 1997; Kim and Drayna 2005; Reed and others 2006). Bitterness is generally recognized as an unpleasant sensation for most people and has to be eliminated from or masked in food products (Drewnowski and Gomez-Carneros 2000). Interestingly, some compounds contributing to bitter tastes in foods have also been known as bioactive compounds working as antioxidants, phytoestrogens, or enzyme inducers on the human body (Drewnowski and Gomez-Carneros 2000). Therefore, more recently, food manufacturers and sensory scientists have focused on investigating sensory properties of these bioactive compounds and reducing undesirable flavors such as bitter, acrid, and astringent flavors while retaining bioactive compounds in the final food products. To date, the de-bittering procedure has included selective breeding of new and less bitter cultivars, removal of bad tasting components, physical barriers like encapsulation, strong masking flavors or tastants such as salt, sweeteners, acids, and strong fruit flavors, and congruent flavors, including chocolate, grapefruit, and coffee (Drewnowski and Gomez-Carneros 2000; Ley 2008).

A segment of the population prefers strong bitter tastes for certain foods and beverages, such as black coffee, dark chocolate, green tea, beer, red wine, and grapefruit (Ley 2008). Some people are even addicted to bitter foods like chocolate and coffee. In particular, chocolate is the most commonly craved food in North America (Bruinsma and Taren 1999). Bitterness of coffee and chocolate has been mainly attributed to caffeine and theobromine in these food products, which are xanthine derivatives. Caffeine (1,3,7-trimethylxanthine) is contained in coffee and chocolate at levels of 0.004 to 0.119 g/100 g and theobromine (3,7-dimethylxanthine) in chocolate and related products at levels of

0.135 to 0.441 g/100 g (Zoumas and others 1980; Barone and Roberts 1996; Serra Bonvehi and Ventura Coll 2000). Recent studies have reported the health benefits of caffeine and theobromine, albeit still in debate. Caffeine has pharmacological effects such as stimulation of the central nervous system, diuresis, alleviation of migraine headaches, lessening of cardiovascular disease, and reduction of fatigue (Winston and others 2005). Theobromine has relatively mild vasodilative and diuretic effects (McShea and others 2008).

Diketopiperazines (DKPs), which are cyclic dipeptides produced during the roasting of cocoa beans, have been identified as another contributor to the bitterness of chocolate (Pickenhagen and others 1975; Stark and Hofmann 2005). Twenty-five DKPs are found in roasted cocoa nibs (Stark and Hofmann 2005). However, there has been little research about which DKPs are more responsible for the bitterness of related foods. Pickenhagen and others (1975) found that the DKPs containing phenylalanine had the closest resemblance to the bitterness of chocolate. Meanwhile, more recent studies identified cyclo (L-Pro-L-Val), which is a cyclic dipeptide consisting of proline and valine, as the most important DKP contributing to the bitterness of roasted cocoa nibs. Cyclo (L-Pro-L-Val) was found to have influenced bitter tastes as much as caffeine in roasted cocoa nibs (Stark and Hofmann 2005; Stark and others 2006).

Ginsenosides, which are triterpenoid saponin glycosides unique to the genera *Panax*, have been believed to be a major contributor to bitterness in ginseng (Schlag and McIntosh 2006). Ginsenosides are contained at levels of 0.7 to 20 g/100 g in ginseng roots (Attele and others 1999; Corthout and others 1999). Little has been reported about the concentrations of ginsenosides in commercial ginseng food products. Most previous research has focused more on pharmacological effects of ginsenosides rather than on their sensory properties. Ginsenosides have stimulatory and inhibitory effects on the central nervous system, growth inhibitory effects against tumor cells, anti-diabetic activities, improvement in impaired memory and learning, recovery response from physical work or aerobic exercise performance, and anti-fatigue effects (Saito and others 1974; Saito and others 1977; Yun and Choi 1995; Duda and others 1996; Engels and others 1996; Engels and Wirth 1997; Salim and others 1997; Attele and others 1999; Li and others 1999; Xie and others 2005). Recently, ginseng is widely utilized in dietary supplements with its numerous health benefits in Western countries. However, U.S. consumers are still unfamiliar with utilization of ginseng in food products due to the limited number of ginseng food products on the market and the peculiar flavors found in these products.

The preceding focus groups, conjoint analysis, and consumer tests identified that the bitterness of ginseng should be eliminated or reduced in future development of novel ginseng food products (Chung 2010a, b, c). Moreover, participants ascertained that the bitterness inherent in ginseng products was different from bitterness in other food products such as coffee and chocolate (Chung 2010a). They characterized the bitter taste in ginseng to last longer than the bitterness found in coffee or chocolate. They also reported that the bitter taste in ginseng was followed by a taste of sweetness. Findings from the preceding studies have suggested that ginseng chocolate would be a potent product which draw interest from U.S. consumers (Chung 2010b, c) and bitterness of coffee and chocolate would be congruent with bitterness of ginseng (Chung 2010a). Therefore, the present study investigated the theory that peculiar ginseng bitter tastes could be masked by chocolate and coffee bitterness, which to most American consumers are more familiar types of bitterness. The objectives of this study were to: 1) profile sensory characteristics of ginseng extract, caffeine, cyclo (L-Pro-L-Val), theobromine, and two model solutions simulating chocolate bitterness and 2) determine the changes in the sensory characteristics of caffeine, cyclo (L-Pro-L-Val), theobromine, and the model solutions by the addition of ginseng extract, with a descriptive analysis method including time-intensity (TI) ratings.

6.3. MATERIALS AND METHODS

Sample Preparation

Thirteen solutions were used both for intensity ratings and TI ratings. These solutions listed along with the composition are found in Table 6.1. Caffeine (Fisher Scientific, Fair Lawn, NJ, USA), cyclo (L-Pro-L-Val) (Bachem, Bubendorf, Switzerland), theobromine (Sigma, St. Louis, MO, USA), and ginseng extract (*Panax* *ginseng*, 80 % ginsenosides, Amax NutraSource, OR, USA) were used for the sample solutions, which were prepared with spring water (Absopure, Urbana, IL, USA).

A model solution simulating milk chocolate bitterness (CBM) was prepared by dissolving 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine per 100 mL of water. Stark and Hofmann (2005) reported that caffeine, cyclo (L-Pro-L-Val), and theobromine were found at levels of 0.101, 0.174, and 1.145 g/100 g in roasted cocoa nibs, respectively. On the other hand, the content of cocoa nibs contained in milk chocolate also depends on manufacturers ranging from 8.5 to 40 % (Beckett 1999). Based on the average of the U.S. (10 %) and European Union (25 %) regulations for the minimum content of cocoa nibs in milk chocolate (EPC 2000; FDA 2009), it was assumed that 17.5 % of cocoa nibs were contained in milk chocolate. Therefore, the model solution simulating milk chocolate bitterness was initially aimed to prepare by dissolving 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.200 g of theobromine per 100 mL of water. However, the final level of theobromine used in this study was re-adjusted to 0.060 g per 100 mL of water due to the low solubility of theobromine in water. This was determined based on a previous finding, including which the portion of compounds insoluble in water would not affect perceptions by humans because only the dissolved substances elicit taste sensation (Szejtli and Szente 2005). Additionally, three single compound solutions were prepared in order to examine their sensory profile by dissolving 0.017 g of caffeine per 100 mL of water (CAF017), 0.030 g of cyclo (L-Pro-L-Val) per 100 mL of water (CPV03), and 0.060 g of theobromine per 100 mL of water (TBM06). These solutions were within the ranges of concentrations of the compounds found in milk chocolate. Based on literature, caffeine is present in the amount of 0.005 to 0.054 g in 100 g of milk chocolate (Zoumas and others 1980; Matissek 1997). Cyclo (L-Pro-L-Val) is present in the amount of 0.015 to 0.070 g in 100 g of milk chocolate, when milk chocolate was considered to include 8.5 to 40 % of cocoa nibs (Beckett 1999; Stark and Hofmann 2005). The concentration level of theobromine used in this study is lower than levels found in milk chocolate, which ranged from 0.135 to 0.188 g in 100 g of milk chocolate, due to the low solubility of theobromine in water (Zoumas and others 1980; Matissek 1997).

Additional higher levels of caffeine and cyclo (L-Pro-L-Val) solutions were used in this study. The higher concentrations of caffeine and cyclo (L-Pro-L-Val) were determined as equi-intense to 0.060 g of theobromine per 100 mL of water through consensus among panelists at the initial stage of panel training. The purpose of the equi-intense determinations was to find the concentrations of caffeine, cyclo (L-Pro-L-Val), and theobromine solutions that will elicit similar intensity of overall bitterness, so as to effectively compare the sensory profile of the solutions to one another when ginseng extract was added. Based on panelist consensus, the concentrations of the two solutions were determined as 0.100 g of caffeine per 100 mL of water and 0.090 g of cyclo (L-Pro-L-Val) per 100 mL of water. Another model solution (HCBM), including higher levels of caffeine and cyclo (L-Pro-L-Val), was prepared by dissolving 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine per 100 mL of water. The concentrations of caffeine and cyclo (L-Pro-L-Val) included in HCBM were also within the range of concentrations found in dark chocolate. Caffeine is present in the amount of 0.017 to 0.125 g in 100 g of dark chocolate (Zoumas and others 1980; Matissek 1997). Cyclo (L-Pro-L-Val) is contained in the range of 0.061 to 0.121 g in 100 g of dark chocolate, when dark chocolate was considered to include 35 to 70 % of cocoa nibs (Beckett 1999; Stark and Hofmann 2005).

Ginseng extract solution was prepared by dissolving 0.010 g of ginseng extract per 100 mL of water (GSE), which was determined as equi-intense to 0.060 g of theobromine per 100 mL of water. The solutions containing ginseng extract were prepared by dissolving 0.010 g of ginseng extract and 0.100 g of caffeine per 100 mL of water (G-CAF1), 0.010 g of ginseng extract and 0.090 g of cyclo (L-Pro-L-Val) per 100 mL of water (G-CPV09), and 0.010 g of ginseng extract and 0.060 g of theobromine per 100 mL of water (G-TBM06). Moreover, 0.010 g of ginseng extract was respectively added to the model solutions prepared in the same manner as preparation of CBM and HCBM (G-CBM and G-HCBM).

Approximately 25 mL of each solution was poured into 29.5-mL of plastic cups (Solo Cup Co., Urbana, IL, USA), labeled with a 3-digit random number with lids for intensity ratings, and 15 mL of each solution was dispensed into 29.5-mL of plastic cups by using a Chempette dispenser (Cole-Parmer Instrument Co., Vernon Hills, IL, USA) for TI ratings. The solutions were stored overnight in a refrigerator (~5 °C) and left at room temperature (~22 °C) at least for 1 hour prior to evaluation by the panelists.

Four basic taste and 6-*n*-propyl-2-thiouracil (PROP) tests were conducted to screen panelists. A 0.7 % sucrose (C&H Sugar Company, Inc., Crockett, CA, USA) solution for sweetness, two 0.1 % sodium chloride (Morton®, Chicago, IL, USA) solutions for saltiness, two 0.05 % citric acid (Tate & Lyle, Decatur, IL, USA) solutions for sourness, two 0.024 % caffeine solutions for bitterness, and spring water were used for the basic taste test. PROP papers were prepared according to Zhao and others (2003). All samples were presented in 29.5-mL of plastic cups with a 3-digit random number with lids.

Ginsenoside Analysis by High Performance Liquid Chromatography

Ginsenosides in the ginseng extract used in the study were profiled by high performance liquid chromatography (HPLC). The ginseng extract has been commercially sold as a food ingredient and labeled as *Panax ginseng* extract, containing 80 % ginsenosides. Crude saponins were extracted according to Shibata and others (1966) and Do and others (1986). Two grams of the ginseng extract powder was extracted in a 250-mL Erlenmeyer flask for 1 hr by refluxing it with 50 mL of water-saturated *n*-butanol at 80 °C. The upper layer of the mixture of water-saturated *n*-butanol and ginseng extract was decanted into another 250-mL Erlenmeyer flask, and another 50 mL of water-saturated *n*-butanol was added to the ginseng extract residue. The extraction of crude sapoinins from the ginseng extract with water-saturated n-butanol was replicated three times. The solvent containing the crude saponins was combined and filtered through a Whatman No. 4 filter paper (Whatman International, Maidstone, UK). The filtrate was cleansed with 20 mL of deionized water through vigorously shaking, and subsequently, evaporated in a vacuum. The dried residue was washed with 50 mL of diethyl ether to remove the fat and then weighed for crude saponin contents.

Ginsenosides of the crude saponin extracts were analyzed according to Hong and others (2009). The crude saponin extracts were dissolved by an appropriate volume of methanol, and filtered through a 0.45 μm polyvinylidene fluoride (PVDF) syringe filter prior to injection into an HPLC system. Ginsenoside analysis was performed on a Jasco

HPLC system (Jasco, Inc., Tokyo, Japan) with a PU-2089 Plus gradient pump equipped with a degasser, an AS-2075 Plus autosampler, and a UV-2075 Plus UV-vis detector. The HPLC system was controlled by a Jasco ChromPass software (Jasco, Inc., Tokyo, Japan). Comparative analyses were conducted using a μ-Bondapak (Waters, Milford, MA, USA) C_{18} column (3.9 × 300 mm i.d., 10 μm pore size) with the column temperature set to 35 ℃. Two mobile phases, water (A) and acetonitrile (B), were used with a liner gradient. The mobile phase A was maintained at 80 % for the first 5 min, decreased from 80 to 67 % over 33 min and from 67 to 20 % in the next 25 min, maintained at 20 % for 12 min, increased from 20 % to 80 % over 5 min, and equilibrated for 10 min before the next injection. The flow rate of mobile phases was 1 mL/min and the ginsenosides were detected at 203 nm. A stock solution of mixed ginsenoside standard containing the ginsenosides Rb_1, Rb_2, Rb_3, Rc, Rd, Re, Rf, Rg_1, Rg_2, Rg_3, Rh_1, and Rh_2 (Fleton Reference Substance Co., Ltd, Chengdu, China) was prepared and diluted to the appropriate concentration for calibration. All solvents were HPLC-grade and were obtained from SK Chemicals (Ulsan, Korea).

Descriptive Analysis Procedure

Subjects

Twelve panelists (3 males and 9 females, 19 to 22 years of age) voluntarily participated in the study. The panelists were selected based on their experience with consuming ginseng foods, availability throughout the entire study, and their capability for sensing basic tastes and PROP. They were all PROP tasters and had above 63 % of correct answers in the basic taste test. They had more than once consumed ginseng foods. The panelists were required to attend one 60-minute session or two 30-minute sessions a day for 19 days. The total time commitment for each panelist was approximately 19 hours.

All twelve panelists participated for the entire period of the descriptive panel. However, one panelist could not detect cocoa bitterness from the samples, and evaluated samples with a large degree of variation during the training period. Therefore, all ratings of this panelist both for the intensity rating and the TI rating were decided to be excluded in the actual data analyses.

Panel Training

Panelists were introduced to descriptive analysis method, including the TI rating, on the first day. In the initial stage of training, the concentrations of caffeine, cyclo (L-Pro-L-Val), and ginseng extract solutions were adjusted until the intensities of the solutions were rated approximately equi-intense to 0.060 g of theobromine/100 mL of water for overall bitterness. Through the following procedure of descriptive term generation and reference generation, a total of 10 descriptive terms were developed for 13 sample solutions. The intensities of references were iteratively rated on a 10-cm line scale by the panelists, and were calculated as the average intensity ratings of the group. The reference intensity values were used as anchors on the scale both for the intensity rating and the TI rating. The final list of descriptive terms, along with the references and reference intensities, is shown in Table 6.2. Prior to actual testing, panelists practiced intensity ratings and TI ratings as a group and individually in booths using a computerized system (Compusense® *five*, version 5.0, Guelph, Ontario, Canada). Specific protocols such as sample volume, the time for sample expectoration, length of evaluation for the TI rating, and rinsing protocol were determined during the training session through consensus among the panelists.

Intensity Rating Procedure

Thirteen solutions were evaluated for 10 attributes using a 10-cm line scale with two word anchors at the end of the line, “none” and “extreme”, and a reference intensity value for corresponding attribute (Table 6.2). Panelists received a set of 10 references (Table 6.2), followed by sample solutions one by one. Panelists evaluated the five bitterness attributes and then the other 5 attributes following the instructions shown on the computer screen. For consistent evaluation process, panelists were instructed to swirl and hold the solution in their mouths for 7 sec. After expectoration, panelists marked the highest intensity perceived during the tasting of the solution on a 10-cm line scale. Between tasting samples, panelists were instructed to rinse their mouths with warm water, bread, and warm water. For the bread rinse, panelists placed a piece of white wheat bread (3 cm × 3 cm, Quality Bakers of America, Inc., Parsippany, NJ, USA) on their tongues, pressed it for 5 sec, and expectorated it. The last warm water rinse was swallowed to remove some residues on the back of the tongue. Panelists tested 6 or 7 sample solutions per 30-minute session and completed two sessions per day with at least two-hour intervals between sessions. All evaluations were replicated and were conducted in individual booths using the Compusense® *five* data acquisition system (version 5.0).

Time-intensity Rating Procedure

Time-intensity (TI) ratings were conducted for the five bitterness attributes including alcohol, coffee, cocoa, grapefruit pith, and medicinal bitterness because the panel identified that temporal perceptions were different among the solutions for these bitterness attributes. A set of five bitterness references (Table 6.2) was presented to panelists, followed by a set of sample solution consisting of five identical solutions at once. Panelists were instructed to place an entire portion of the solution contained in each cup in their mouths, swirl, and hold it in their mouths for 10 sec per bitterness attribute. The time to hold solutions in their mouths was extended during training of the TI rating because panelists needed extra time for their evaluation due to the difficulty in simultaneously perceiving, evaluating, and recording the changes in the attribute intensity. Each panelist clicked the start button on the computer screen as soon as he/she placed the solution in his/her mouth, then moved the slider left and right according to the intensity change on a 10-cm line scale. The TI rating was recorded continuously every 0.5 sec for the duration of 60 sec by a computerized TI program. The descriptors, “none” and “extreme”, were marked at the end of the line and a reference intensity value was also marked at the corresponding point (Table 6.2). A timer was displayed on the computer screen to inform the panelists of the expectoration and remaining evaluation time. Once panelists completed evaluation of five bitterness attributes of a set of 5 identical solutions, they were presented another set of sample solutions consisting of another five identical solutions. Six or 7 sets of sample solutions were randomly presented to the panelists per session, each of which lasted for about 60 minutes. The rinsing protocol was identical to the method used in the intensity rating. All evaluations were replicated and were conducted in individual booths using the Compusense® *five* data acquisition system (version 5.0).

Statistical Analyses

Intensity ratings of 10 attributes were evaluated by analysis of variance (ANOVA) using Statistical Analysis Software (SAS, version 9.2, SAS Institute, Inc., Cary, NC, USA). Fisher's least significant difference (LSD) procedure was performed on intensity ratings for the attributes with significance across the samples by ANOVA (SAS, version 9.2). For the comparison of sensory profiles among a model solution and three single compound solutions comprising the model solution, ANOVA and Fishers' LSD procedure were performed on each of two sets of four solutions. In order to examine effects of ginseng extract on three single compound solutions and two model solutions, ANOVA and Fisher's LSD were conducted within each set of three solutions consisting of GSE, a solution without ginseng, and the corresponding solution with ginseng.

In regard to the TI rating, initial intensity (I_{int}), maximum intensity (I_{max}), time to maximum intensity (T_{max}), and duration time (T_{dur}) were extracted from the generated TI curves and were analyzed by ANOVA and Fisher's LSD procedure, which were conducted within each set of three solutions consisting of GSE, a solution without ginseng, and the corresponding solution with ginseng.

Principal component analysis (PCA) was performed on the covariance matrix of mean intensity ratings of attributes significant at $p < 0.05$ and on the correlation matrix of mean scores of TI parameters for five bitterness significant at $p < 0.05$ across 13 solutions using XLSTAT (version 2009, Addinsoft, New York, NY, USA). Agglomerative hierarchical cluster analysis by the Euclidean distance for the dissimilarity scale by the Ward's method was conducted both for the mean intensity ratings of attributes significant at $p < 0.05$ and the mean scores of TI parameters significant at $p < 0.05$ across 13 solutions, and correlation between bitterness attributes was tested using TI parameters significant at $p < 0.05$ by XLSTAT (version 2009).

6.4. RESULTS AND DISCUSSION

Profile of Ginsenosides in Ginseng Extract

The ginseng extract used in this study contained 88.90 g of crude saponins per

100 g of ginseng extract. The profile of ginsenosides contained in the ginseng extract is shown in Table 6.3. Although more than 27 putative ginsenosides have been isolated from ginseng roots (Schlag and McIntosh 2006), the 12 most abundant ginsenosides were analyzed in this study. The total amount of ginsenosides examined was 62.54 g in 100 g of ginseng extract. The relative abundance of the four most abundant ginsenosides was Re > Rd > Rb_1 > Rg_1, which formed 75 % of the total amount of ginsenosides. Ginsenoside Rf was present in the amount of 0.4 % of the total amount of ginsenoside and the ratio of ginsenosides Rg_1 to Rb_1 was 0.96.

The amounts and ratios of ginsenosides vary depending on the variety, age, and part of the ginseng, soil fertility, and location (Court and others 1996; Corthout and others 1999; Li and Mazza 1999; Assinewe and others 2003). The ginseng extract used in the study was highly concentrated in terms of ginsenoside content, compared to dried ginseng roots which generally contain 0.7 to 20 g of ginsenosides in 100 g of dried ginseng root (Attele and others 1999; Corthout and others 1999). The ratio of Rg_1 to Rb_1 of the ginseng extract was much higher than those pertaining to American ginseng (*Panax quinquefolius* L.) reported in previous studies, which ranged from 0.14 to 0.18 (Harkey and others 2001; Hu and Kitts 2001). Previous research has found that American ginseng has little or no ginsenoside Rf and has a lower ratio of Rg_1 to Rb_1 than Asian ginseng (*Panax ginseng* C.A. Meyer) (Wang and others 1999; Harkey and others 2001). Based on HPLC analysis, the ginseng extract solution (GSE) used in this study included approximately 0.00625 g of ginsenosides per 100 mL of the solution. There has been little data about ginsenoside concentrations in commercial ginseng food products. Some commercial food products list ginseng or ginseng extract contents in the nutrition facts on their packaging. However, there are no products specifying what concentrations of ginsenosides are contained in the products as well as in the ginseng or ginseng extracts used in the products. Eight energy drink products containing ginseng or ginseng extract available in local grocery stores (Urbana, IL, USA) contained 0.01 to 0.08 g of ginseng or ginseng extract per 100 mL of the drinks. When the fact was considered that standardized ginseng extracts used for commercial ginseng preparations contained 4 to 8 g of ginsenosides in 100 g of standardized ginseng extract (Li and Wang 1998), it could be estimated that 0.0004 to 0.0064 g of ginsenosides were contained per 100 mL of commercial energy drinks. Therefore, ginsenoside concentration of GSE was within the upper range of the concentrations found in commercial energy drinks.

Sensory Characteristics of Caffeine, Cyclo (L-Pro-L-Val), Theobromine, and Two Chocolate Bitterness Model Solutions

Five single compound solutions and two model solutions were compared to one another in terms of the sensory descriptive terms developed in this study and were examined as to whether or not any synergistic or suppressive effects were found among compounds present in the model solutions based on intensity ratings (Table 6.4). Mean intensity ratings for 10 attributes of a model solution simulating milk chocolate bitterness (CBM) and three single compound solutions comprising CBM are found in Table 6.4.a. CBM was not significantly different from TBM06 regarding the five bitterness attributes examined in this study. Although CAF017 and CPV03 were rated from 1.4 to 2.3 for the five bitterness attributes, 0.017 g of caffeine and 0.030 g of cyclo (L-Pro-L-Val) included in CBM did not significantly intensify the five bitterness of CBM as much as the bitterness intensities of CAF017 and CPV03. This indicated that bitterness characteristics of CBM were mainly influenced by theobromine rather than caffeine or cyclo (L-Pro-L-Val) included in CBM. This was due to relatively large amounts of theobromine in CBM. The concentrations of CAF017 and CPV03 were within ranges of the respective threshold values. Threshold values of caffeine have been reported as ranging from 0.014 to 0.035 g/100 mL for bitter taste (Robinson and others 2004; Stark and others 2006), and threshold values of cyclo (L-Pro-L-Val) varies from 0.025 to 0.050 g/100 mL for bitter taste and from 0.001 to 0.020 g/100 mL for metallic, lingering, and salty tastes, as well as mouth-feel (Gautschi and Schmid 1997; Stark and Hofmann 2005; Chen and others 2009). Pickenhagen and others (1975) observed a synergistic effect between theobromine and diketopiperazines. The authors found that when 0.01 g of theobromine was added to 0.005 g of cyclo (L-Val-L-Phe)/100 mL of water, the bitterness intensity of the mixed solution increased to a much higher level than the sum of intensities of individual solutions. However, the present study did not reveal any synergistic effects for the five bitterness attributes among the compounds comprising CBM. In regard to the other attributes beside the five bitterness attributes, means of intensity ratings for sourness, green tea, and astringency attributes were significantly different across CAF017, CPV03, TBM06, and CBM. However, mean intensity ratings of CBM were not significantly different from those of TBM06 for the three attributes. From the findings, we concluded that theobromine was the most important contributor to the bitterness found in the model solution simulating milk chocolate bitterness (CBM) among the three major bitter compounds, denoting that taste characteristics of milk chocolate were mostly dominated by the content of theobromine.

Mean intensity ratings for 10 attributes of three single compound solutions prepared at equi-intense and HCBM are given in Table 6.4.b. Despite efforts to prepare the solutions at equi-intense, CPV09 was rated relatively lower than CAF1 and TBM06 for most attributes. This may be due to using a different evaluation method between panel training and an actual intensity rating. In the panel training, equi-intense was estimated for overall bitterness because it took place before the descriptive terms were developed, but in actual intensity testing, the evaluation was performed for each of five bitterness terms generated through panel training. CAF1 was characterized as having relatively more cocoa bitterness, and TBM06 as having more grapefruit pith bitterness than the other two solutions. CPV09 was sweeter than CAF1 and TBM06. Caffeine has been described as possessing a unique bitter taste or being unable to be replicated by using any other bitter compounds (Allison and Chambers IV 2000). Theobromine has been known to have a metallic bitter taste and to be recognized in the rear portion of the tongue (Pickenhagen and others 1975). Cyclo (L-Pro-L-Val) has been reported as having bitter, metallic, lingering, and salty tastes (Gautschi and Schmid 1997; Stark and Hofmann 2005; Chen and others 2009). In the present study, metallic and lingering tastes were generated in the initial stage of the panel training. However, the terms were excluded in the final list during refining of descriptive terms by the panel. HCBM was rated significantly higher for all five bitterness attributes than CAF1, CPV09, and TBM06, except for the cocoa bitterness of CAF1. However, the bitterness intensities of HCBM were much less than the sum of the individual intensities of the three compounds. For instance, the cocoa bitterness intensity of HCBM was 5.5, but the sum of the individual intensities of the constituent compounds was 13.1. This agreed with Bartoshuk and Cleveland (1977) demonstrating that the final bitterness did not increase as much as the predicted sum of individual intensities when different bitter compounds were mixed. For sweetness, HCBM was rated significantly lower than CPV09 and was not significantly different from CAF1 and TBM06, indicating that the sweetness of CPV09 did not induce an increase in the sweetness of HCBM. This might result from mixture suppression between sweetness and bitterness, which could be partially explained by an antagonistic binding of sweet compounds to the same receptor targets that bind bitter compounds (Ming and others 1999). Because bitterness was a more predominant attribute in CAF1, CPV09, and TBM06 than sweetness, sweetness was more suppressed by bitterness (rather than the reverse) in HCBM.

Effects of Ginseng Extracts on Sample Solutions

Evaluation by Intensity Rating

Mean intensity ratings of the sample solutions for the 10 attributes are given in Table 6.5. G-CAF1 and G-CPV09 were intensified in alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness by adding ginseng extract to the corresponding solutions without ginseng extract, when compared to CAF1 and CPV09, respectively (Tables 6.5.a and 6.5.b and Figures 6.1 and 6.2). Meanwhile, sweetness of G-CAF1 and G-CPV09 and starchiness of G-CAF1 were significantly lower than those of GSE but were not significantly different from the corresponding attributes of CAF1 and CPV09. The addition of ginseng extract to TBM06 also increased alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness, when compared to TBM06 (Table 6.5.c and Figure 6.3). In addition, G-TBM06 was significantly lower in sweetness than GSE and significantly higher in sweetness and green tea attribute than TBM06. These findings illustrate that TBM06 is more influenced by the addition of ginseng extract than CAF1 and CPV09. Thus, it was concluded that theobromine has less of a masking effect on the unique tastes of ginseng extract than the other single bitter compounds. Table 6.5.d and Figure 6.4 show that G-CBM was intensified in alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness when compared to CBM. On the other hand, G-CBM was significantly lower in sweetness, green tea, astringency, and starchiness than GSE, while G-CBM was not significantly different from CBM in intensities of those attributes. The addition of ginseng extract to HCBM increased only the medicinal bitterness in G-

HCBM (Table 6.5.e and Figure 6.5), indicating that HCBM was influenced the least by the addition of ginseng extract among the sample solutions examined in this study. Mean intensity ratings for sweetness, green tea, and starchiness of G-HCBM were significantly lower than those of GSE. This may have resulted from more caffeine and cyclo (L-Pro-L-Val) included in HCBM than in CBM. Dark chocolate generally contains more caffeine (ranging from 0.017 to 0.125 g/100 g) than milk chocolate (ranging from 0.005 to 0.054 g/100 g) (Zoumas and others 1980). Although there has been no research reporting the content of DKPs in commercial chocolate products, dark chocolate should contain more DKPs, including cyclo (L-Pro-L-Val), than milk chocolate because dark chocolate generally contains more cocoa nibs than milk chocolates (Beckett 1999). On the other hand, Table 6.5 and Figures 6.1 to 6.5 show that sweetness, green tea, and starchiness were distinctive attributes in GSE, when compared to the sample solutions without ginseng extract. Those attributes of GSE were significantly lowered when ginseng extract was mixed with the two model solutions, so that mean intensity ratings for those attributes of G-CBM and G-HCBM were not significantly different from CBM and HCBM, respectively. These findings imply that dark chocolate may be a more effective medium to mask ginseng bitterness than milk chocolate. This confirmed the findings from the preceding focus group study, in which panelists identified that the bitter taste in ginseng was followed by a taste of sweetness (Chung 2010a). Earthy and musty flavors, which were identified as peculiar flavors in ginseng products in the preceding focus group study, were not generated by the descriptive panel for GSE as well as the other solutions with ginseng extract. This might result from partial removal of the compounds responsible for earthy and musty flavors in the ginseng extract used in this study.

ANOVA performed on intensity ratings of 10 attributes for all 13 solutions revealed that five bitterness attributes, sweetness, green tea, and astringency were significant at $p < 0.001$, and sourness and starchiness at $p < 0.01$. An agglomerative hierarchical cluster analysis divided 13 solutions into 3 groups and the dendrogram is shown in Figure 6.6. Group 1 included CAF017 and CPV03, and Group 2 consisted of CPV09 and GSE. Group 3 included CAF1, TBM06, CBM, HCBM, G-CAF1, G-CPV09, G-TBM06, G-CBM, and G-HCBM. Group 3 consists of two sub-groups; Group 3A for CAF1, TBM06, CBM, and G-CPV09, and Group 3B for G-CAF1, G-TBM06, G-CBM, HCBM, and G-HCBM. A biplot of PCA performed with mean intensity ratings of 10 attributes is presented in Figure 6.7. PC 1 explained 89.2 % of the variance and PC 2 accounted for 6.9 % of the variance, for a total of 96.1 % of variance by the biplot. The five bitterness attributes were loaded on PC 1 and sweetness and starchiness was loaded on PC 2. The three groups of sample solutions segmented by cluster analysis were also identified on the biplot of PCA using different bullet points (Figure 6.7). Group1 was not explained well with any attributes studied, as located in opposite direction of most attributes. This might be caused by very weak intensities of attributes in those two solutions as shown in Table 6.4.a. Group 2, including CPV09 and GSE, was mostly characterized by sweetness and starchiness. Most solutions in Group 3 were characterized as having more of the five bitterness attributes than the other two groups. In particular, Group 3B consisting of the solutions with ginseng extract except HCBM, was mostly characterized as being stronger in the five bitterness attributes than Group 3A. This indicates that the addition of ginseng extract intensified five bitterness attributes in most solutions, with the exception of HCBM (Table 6.5.e and Figures 6.5 to 6.7).

Evaluation by Time-intensity Rating

Mean scores of the TI parameters are given in Table 6.6. G-CAF1 received higher mean scores of I_{max} for all bitterness attributes except coffee bitterness, I_{int} for medicinal bitterness, and T_{dur} for alcohol bitterness, when compared to CAF1 (Table 6.6.a). G-CPV09 was rated higher in I_{max} for alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness, T_{max} for cocoa bitterness, and T_{dur} for medicinal bitterness than the corresponding solution without ginseng extract (CPV09) (Table 6.6.b). Meanwhile, I_{int} for cocoa bitterness and grapefruit pith bitterness, and T_{max} for grapefruit pith bitterness of G-CPV09 were lower than those of CPV09. G-TBM06 received lower mean scores of I_{max} for cocoa bitterness and T_{max} for grapefruit pith bitterness than TBM06 (Table 6.6.c). CBM and HCBM were not much influenced by the addition of ginseng extract in terms of mean scores of TI parameters. G-CBM was significantly increased in T_{dur} for alcohol bitterness (Table 6.6.d) and G-HCBM received significantly higher mean scores for T_{dur} for alcohol bitterness and medicinal bitterness. In summary, the addition of ginseng extract influenced more of TI parameters of G-CAF1 and G-CPV09 than those of G-

CBM and G-HCBM, when compared to the corresponding solutions without ginseng extract. In particular, G-CAF1 and G-CPV09 were mainly increased in I_{max}, when compared to CAF1 and CPV09, respectively, and G-CBM and G-HCBM had longer duration in certain bitterness attributes than CBM and HCBM. This indicates that the addition of ginseng extract increases intensities of bitterness in the solutions having relatively lower intensities of bitterness, such as CAF1 and CPV09, and extends duration of certain bitterness attributes in higher concentrations of solutions such as CBM and HCBM. This might be partially explained by saturation of taste receptors by high concentration levels of solutions. Saturation of taste receptor system has shown to cause no further increases in perceived intensity (Keast and Breslin 2003), as shown in intensity-related parameters of G-CBM and G-HCBM. The findings demonstrate that the longer duration of certain bitterness attributes in G-CBM and G-HCBM may be a factor that enables people to distinguish the solutions from the corresponding solutions without ginseng extract.

ANOVA performed on the scores of I_{int}, I_{max}, T_{max}, and T_{dur} of each bitterness attribute for all 13 solutions showed that T_{max} for coffee bitterness and medicinal bitterness were not significantly different across 13 solutions. T_{dur} for cocoa bitterness and T_{max} for grapefruit pith bitterness were significantly different across the solutions at $p < 0.05$, T_{max} for alcohol bitterness and cocoa bitterness, I_{int} for alcohol bitterness and coffee bitterness, and T_{dur} for coffee bitterness at $p < 0.01$, and the other parameters at $p < 0.001$. Thus, the correlation test, cluster analysis, and PCA were performed with mean scores of the significant 18 parameters, excluding T_{max} for coffee bitterness and medicinal bitterness. Table 6.7 shows the correlation among the 18 significant parameters for five bitterness attributes of 13 sample solutions. T_{max} for alcohol bitterness, cocoa bitterness, and grapefruit pith bitterness did not have significant correlation with any other TI parameters, demonstrating that T_{max} did not influence I_{int}, I_{max}, and T_{dur} of any other bitterness. Meanwhile, each bitterness attribute was significantly correlated to one another within I_{max} and T_{dur}, respectively, and between I_{max} and T_{dur}. This demonstrates that increase in the maximum intensity of bitterness extends the duration of bitterness in the solutions used in the study.

The dendrogram of agglomerative hierarchical cluster analysis is shown in Figure 6.8. The cluster analysis with 18 significant TI parameters divided 13 solutions into 3 groups. The solutions comprising each group were identical to the results from the preceding cluster analysis performed with intensity ratings of 10 significant attributes. The biplot of PCA performed with mean scores of 18 significant TI parameters is shown in Figure 6.9. A total of 76.2 % of variance was explained by the first two PCs. PC 1 accounted for 63.7 % of the variance being strongly loaded with T_{dur} and I_{max} of all five bitterness. PC 2 explained 12.5 % of the variance being loaded with T_{max} of alcohol bitterness, cocoa bitterness, and grapefruit pith bitterness. CAF017, CAF1, CPV03, and GSE were not characterized by any TI parameters for five bitterness attributes. G-CPV09 and G-TBM06 were more characterized as to have higher T_{max} for alcohol bitterness and cocoa bitterness than the corresponding solutions without ginseng extract, which means that addition of ginseng extract to CPV09 and TBM06 delayed the time to reach to maximum intensity of alcohol bitterness and cocoa bitterness. TBM06, HCBM, G-CAF1, G-CBM, and G-HCBM were more characterized as having higher I_{int} for cocoa bitterness and grapefruit pith bitterness, illustrating that cocoa bitterness and grapefruit pith bitterness of these solutions were perceived in relatively high intensity at first when compared to the other solutions. I_{max} and T_{dur} of five bitterness attributes were clustered together on the biplot, indicating that the two parameters for all five bitterness attributes were strongly correlated to one another.

6.5. CONCLUSIONS

Ginseng extract was characterized to have more sweetness, green tea, and starchiness than caffeine, cyclo (L-Pro-L-Val), theobromine, and two model solutions. Those attributes could be masked by individual caffeine and cyclo (L-Pro-L-Val) solutions at concentrations found in coffee and dark chocolate as well as a model solution simulating milk chocolate bitterness, although intensities of certain bitter attributes were increased. However, a higher level of chocolate bitterness such as dark chocolate bitterness could effectively mask the distinctive ginseng tastes with a minimal increase in intensities of bitterness attributes. Therefore, dark chocolate could be proposed as the medium to incorporate ginseng extract so as to add this healthful ingredient into the American diet without compromising the taste. Future studies may include profiling sensory characteristics of those bitter compounds by using different food matrices from water, which was the matrix used in this study. These might include such foods as milk or cocoa butter. Additionally, major aroma compounds found in chocolate and coffee may be added to investigate the effect of congruent flavors on further masking the bitter taste of ginseng.

6.6. TABLES AND FIGURES

Table 6.1. Sample solution codes and composition used for intensity ratings and time-intensity ratings

Sample code	Composition [per 100 mL of water]
CAF017	0.017 g of caffeine
CAF1	0.100 g of caffeine
CPV03	0.030 g of cyclo (L-Pro-L-Val)
CPV09	0.090 g of cyclo (L-Pro-L-Val)
TBM06	0.060 g of theobromine
CBM	0.017 g of caffeine + 0.030 g of cyclo (L-Pro-L-Val) + 0.060 g of theobromine
HCBM	0.100 g of caffeine + 0.090 g of cyclo (L-Pro-L-Val) + 0.060 g of theobromine
GSE	0.010 g of ginseng extract
G-CAF1	0.010 g of ginseng extract + 0.100 g of caffeine
G-CPV09	0.010 g of ginseng extract + 0.090 g of cyclo (L-Pro-L-Val)
G-TBM06	0.010 g of ginseng extract + 0.060 g of theobromine
G-CBM	0.010 g of ginseng extract + 0.017 g of caffeine + 0.030 g of cyclo (L-Pro-L-Val) + 0.060 g of theobromine
G-HCBM	0.010 g of ginseng extract + 0.100 g of caffeine + 0.090 g of cyclo (L-Pro-L-Val) + 0.060 g of theobromine

Table 6.2. Descriptive terms, reference, reference preparation, and reference intensity values developed by the descriptive panel (*n* = 12)

Descriptive term	Reference	Reference preparation	Intensity[§]
Alcohol bitterness	4 % diluted vodka (v/v)	Wolfschmidt® Genuine vodka (Wolfschmidt, Frankfort, KY, USA) mixed with water	5.8
Coffee bitterness	Brewed coffee	Two coffee bags of Folgers Class Roast® Singles (Procter & Gamble Co., Cincinnati, OH, USA) brewed in 500 mL of hot water for 4 hrs	5.3
Grapefruit pith bitterness	Grapefruit pith	Grapefruit pith (1 cm × 1 cm)	7.6
Medicinal bitterness	Tylenol tablet	Tylenol® Regular Strength tablet (McNeil-PPC, Inc., Fort Washington, PA, USA)	8.1
Cocoa bitterness	4 % cocoa solution (w/v)	Hershey's® Cocoa Special Dark (The Hershey Company, Hershey, PA, USA) suspended in water	7.2
Sourness	0.04 % citric acid (w/v)	Citric acid (Tate & Lyle, Decatur, IL, USA) dissolved in water	6.5
Sweetness	0.7 % sucrose (w/v)	C&H pure crane sugar (C&H Sugar Company, Inc., Crockett, CA, USA) dissolved in water	7.0
Green tea	Brewed green tea	A teabag of Full Circle™ green tea (Topco Associates LLC., Skokie, IL, USA) brewed in 500 mL of hot water for 1 min	6.7
Astringency	0.08 % grape tannin (w/v)	Natural grape tannin (Presque Isle Wine Cellars, North East, PA, USA) dissolved in water	6.8
Starchiness	1 % starch solution (w/v)	Gold Medal® flour (General Mills Inc., Minneapolis, MN, USA) suspended in water	5.8

[§] Reference intensity values were determined on a 10-cm line scale.

Table 6.3. Profile of ginsenosides in ginseng extract (*Panax ginseng*) used in this study by high performance liquid chromatography

Ginsenoside	Amount [g per 100 g]	Standard deviation [g per 100 g]
Rg_1	7.38	0.21
Re	21.60	0.23
Rf	0.27	0.04
Rg_2 + Rh_1	4.44	0.11
Rb_1	7.72	0.12
Rc	3.60	0.11
Rb_2 + Rb_3	6.11	0.06
Rd	10.38	0.05
Rg_3	0.97	0.05
Rh_2	0.06	0.01
Total	62.54	

Table 6.4. Mean intensity ratings for 10 attributes on a 10-cm line scale; (a) 0.017 g of caffeine/100 mL (CAF017), 0.030 g of cyclo (L-Pro-L-Val)/100 mL (CPV03), 0.060 g of theobromine/100 mL (TBM06), and a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (CBM), and (b) 0.100 g of caffeine/100 mL (CAF1), 0.090 g of cyclo (L-Pro-L-Val)/100 mL (CPV09), TBM06, and a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (HCBM)

Attribute	(a)				(b)			
	CAF017[§]	CPV03	TBM06	CBM	CAF1	CPV09	TBM06	HCBM
Alcohol bitterness	1.4^{b}	1.6^{b}	4.2^{a}	4.7^{a}	4.2^{b}	2.9^{c}	4.2^{b}	5.8^{a}
Coffee bitterness	1.5^{b}	1.4^{b}	3.7^{a}	3.7^{a}	3.4^{b}	2.4^{c}	3.7^{b}	4.3^{a}
Cocoa bitterness	1.9^{b}	1.5^{b}	4.7^{a}	4.6^{a}	5.2^{ab}	3.2^{c}	4.7^{b}	5.5^{a}
Grapefruit pith bitterness	2.3^{b}	1.9^{b}	5.4^{a}	5.2^{a}	4.6^{c}	3.2^{d}	5.4^{b}	6.7^{a}
Medicinal bitterness	1.6^{b}	1.4^{b}	5.4^{a}	5.9^{a}	5.3^{b}	3.0^{c}	5.4^{b}	7.2^{a}
Sourness	2.5^{b}	2.1^{b}	3.9^{a}	3.6^{a}	3.5^{a}	3.0^{a}	3.9^{a}	3.5^{a}
Sweetness	3.0^{a}	2.4^{a}	2.0^{a}	2.1^{a}	1.9^{b}	3.0^{a}	2.0^{b}	1.8^{b}
Green tea	2.8^{b}	2.4^{b}	3.8^{a}	3.9^{a}	4.1^{a}	3.9^{a}	3.8^{a}	3.6^{a}
Astringency	2.6^{b}	2.8^{b}	4.5^{a}	4.1^{a}	3.9^{a}	3.9^{a}	4.5^{a}	4.2^{a}
Starchiness	2.8^{a}	2.5^{a}	2.8^{a}	2.5^{a}	3.1^{a}	3.0^{a}	2.8^{a}	2.7^{a}

[§] Means with the same letters in a row of each sub-table, (a) and (b), are not significantly different at $p < 0.05$ ($n = 11$).

Table 6.5. Mean intensity ratings for 10 attributes on a 10-cm line scale; (a) 0.010 g of ginseng extract/100 mL (GSE), 0.100 g of caffeine/100 mL (CAF1), and CAF1 with 0.010g of ginseng extract (G-CAF1), (b) GSE, 0.090 g of cyclo (L-Pro-L-Val)/100 mL (CPV09), and CPV09 with 0.010g of ginseng extract (G-CPV09), (c) GSE, 0.060 g of theobromine/100 mL (TBM06), and TBM06 with 0.010g of ginseng extract (G-TBM06), (d) GSE, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (CBM), and CBM with 0.010g of ginseng extract (G-CBM), and (e) GSE, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (HCBM), and HCBM with 0.010g of ginseng extract (G-HCBM)

Attribute	(a)			(b)			(c)			(d)			(e)		
	GSE[§]	CAF1	G-CAF1	GSE	CPV09	G-CPV09	GSE	TBM06	G-TBM06	GSE	CBM	G-CBM	GSE	HCBM	G-HCBM
Alcohol bitterness	3.9^{b}	4.2^{b}	5.2^{a}	3.9^{a}	2.9^{b}	4.6^{a}	3.9^{b}	4.2^{b}	5.7^{a}	3.9^{c}	4.7^{b}	5.4^{a}	3.9^{b}	5.8^{a}	6.0^{a}
Coffee bitterness	2.9^{b}	3.4^{ab}	4.0^{a}	2.9^{a}	2.4^{a}	3.3^{a}	2.9^{b}	3.7^{a}	3.9^{a}	2.9^{b}	3.7^{a}	3.8^{a}	2.9^{b}	4.3^{a}	4.4^{a}
Cocoa bitterness	3.6^{b}	5.2^{a}	4.9^{a}	3.6^{a}	3.2^{a}	4.3^{a}	3.6^{b}	4.7^{a}	5.0^{a}	3.6^{b}	4.6^{a}	4.9^{a}	3.6^{b}	5.5^{a}	5.5^{a}
Grapefruit pith bitterness	4.1^{b}	4.6^{b}	6.6^{a}	4.1^{b}	3.2^{c}	5.9^{a}	4.1^{c}	5.4^{b}	7.1^{a}	4.1^{c}	5.2^{b}	6.7^{a}	4.1^{b}	6.7^{a}	7.2^{a}
Medicinal bitterness	3.8^{c}	5.3^{b}	6.9^{a}	3.8^{b}	3.0^{b}	5.1^{a}	3.8^{c}	5.4^{b}	7.6^{a}	3.8^{c}	5.9^{b}	7.0^{a}	3.8^{c}	7.2^{b}	7.9^{a}
Sourness	3.3^{a}	3.5^{a}	3.6^{a}	3.3^{a}	3.0^{a}	3.7^{a}	3.3^{a}	3.9^{a}	3.1^{a}	3.3^{a}	3.6^{a}	3.6^{a}	3.3^{a}	3.5^{a}	3.2^{a}
Sweetness	4.8^{a}	1.9^{b}	2.2^{b}	4.8^{a}	3.0^{b}	2.6^{b}	4.8^{a}	2.0^{c}	2.7^{b}	4.8^{a}	2.1^{b}	2.4^{b}	4.8^{a}	1.8^{b}	1.5^{b}
Green tea	4.6^{a}	4.1^{a}	4.2^{a}	4.6^{a}	3.9^{a}	4.3^{a}	4.6^{a}	3.8^{b}	4.6^{a}	4.6^{a}	3.9^{ab}	3.3^{b}	4.6^{a}	3.6^{b}	3.5^{b}
Astringency	4.9^{a}	3.9^{a}	4.3^{a}	4.9^{a}	3.9^{a}	4.4^{a}	4.9^{a}	4.5^{a}	4.5^{a}	4.9^{a}	4.1^{b}	3.9^{b}	4.9^{a}	4.2^{a}	4.5^{a}
Starchiness	3.8^{a}	3.1^{b}	2.7^{b}	3.8^{a}	3.0^{a}	2.9^{a}	3.8^{a}	2.8^{b}	3.1^{ab}	3.8^{a}	2.5^{b}	2.6^{b}	3.8^{a}	2.7^{b}	2.1^{b}

[§] Means with the same letters in a row of each sub-table, (a), (b), (c), (d), and (e), are not significantly different at $p < 0.05$ ($n = 11$).

Table 6.6. Mean scores of time-intensity parameters for five bitterness attributes on a 10-cm line scale; (a) 0.010 g of ginseng extract/100 mL(GSE), 0.100 g of caffeine/100 mL (CAF1), and CAF1 with 0.010g of ginseng extract (G-CAF1), (b) GSE, 0.090 g of cyclo (L-Pro-L-Val)/100 mL (CPV09), and CPV09 with 0.010g of ginseng extract (G-CPV09), (c) GSE, 0.060 g of theobromine/100 mL (TBM06), and TBM06 with 0.010g of ginseng extract (G-TBM06), (d) GSE, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (CBM), and CBM with 0.010g of ginseng extract (G-CBM), and (e) GSE, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (HCBM), and HCBM with 0.010g of ginseng extract (G-HCBM)

TI		(a)			(b)			(c)			(d)			(e)		
Parameters		GSE[§]	CAF1	G-CAF1	GSE	CPV09	G-CPV09	GSE	TBM06	G-TBM06	GSE	CBM	G-CBM	GSE	HCBM	G-HCBM
	ALB	0.9^{a}	1.3^{a}	1.6^{a}	0.9^{a}	0.9^{a}	1.4^{a}	0.9^{a}	1.0^{a}	1.6^{a}	0.9^{b}	1.9^{a}	1.2^{b}	0.9^{a}	1.6^{a}	2.1^{a}
	CFB	0.8^{a}	0.7^{a}	1.1^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.5^{a}	1.3^{a}	0.8^{b}	1.4^{a}	0.8^{b}	0.8^{a}	0.8^{a}	1.0^{a}
I_{int}[†¶]	CCB	0.8^{a}	1.1^{a}	1.7^{a}	0.8^{b}	1.7^{a}	0.5^{b}	0.8^{a}	1.2^{a}	0.9^{a}	0.8^{a}	1.0^{a}	1.6^{a}	0.8^{b}	1.7^{a}	2.1^{a}
	GPB	0.8^{a}	1.1^{a}	1.1^{a}	0.8^{b}	1.7^{a}	1.0^{b}	0.8^{a}	1.4^{a}	1.2^{a}	0.8^{b}	1.9^{a}	2.1^{a}	0.8^{a}	1.7^{a}	1.8^{a}
	MDB	0.8^{b}	1.1^{b}	2.3^{a}	0.8^{a}	1.0^{a}	1.9^{a}	0.8^{b}	2.4^{a}	1.6^{ab}	0.8^{a}	0.9^{a}	1.5^{a}	0.8^{a}	1.8^{a}	1.4^{a}
	ALB	4.9^{b}	4.0^{c}	6.2^{a}	4.9^{b}	4.0^{c}	5.7^{a}	4.9^{a}	5.1^{a}	5.5^{a}	4.9^{a}	5.4^{a}	5.7^{a}	4.9^{b}	6.0^{a}	6.5^{a}
	CFB	3.8^{a}	3.7^{a}	4.6^{a}	3.8^{a}	3.2^{a}	3.9^{a}	3.8^{a}	4.1^{a}	4.5^{a}	3.8^{a}	4.5^{a}	4.7^{a}	3.8^{b}	4.9^{a}	5.5^{a}
I_{max}	CCB	4.2^{b}	4.2^{b}	5.8^{a}	4.2^{a}	3.5^{a}	4.8^{a}	4.2^{b}	5.9^{a}	4.7^{b}	4.2^{a}	5.9^{a}	5.4^{a}	4.2^{b}	5.9^{a}	5.7^{a}
	GPB	4.5^{c}	5.4^{b}	6.9^{a}	4.5^{b}	4.9^{b}	5.9^{a}	4.5^{b}	6.6^{a}	6.1^{a}	4.5^{b}	6.8^{a}	7.1^{a}	4.5^{b}	7.2^{a}	7.4^{a}
	MDB	4.6^{b}	5.1^{b}	7.3^{a}	4.6^{b}	4.1^{b}	6.4^{a}	4.6^{b}	6.8^{a}	6.7^{a}	4.6^{b}	6.9^{a}	7.1^{a}	4.6^{b}	7.8^{a}	8.0^{a}
	ALB	8.4^{a}	7.3^{a}	8.2^{a}	8.4^{a}	8.0^{a}	11.6^{a}	8.4^{a}	9.6^{a}	11.8^{a}	8.4^{a}	9.7^{a}	8.0^{a}	8.4^{a}	8.8^{a}	7.5^{a}
	CFB	7.7^{a}	9.6^{a}	8.3^{a}	7.7^{a}	6.8^{a}	9.3^{a}	7.7^{a}	8.1^{a}	8.4^{a}	7.7^{a}	9.2^{a}	10.6^{a}	7.7^{a}	10.5^{a}	9.6^{a}
T_{max}	CCB	5.6^{a}	7.6^{a}	8.1^{a}	5.6^{b}	7.3^{b}	14.0^{a}	5.6^{a}	7.9^{a}	6.5^{a}	5.6^{a}	7.9^{a}	8.3^{a}	5.6^{b}	8.4^{ab}	12.3^{a}
	GPB	7.2^{b}	8.6^{ab}	10.6^{a}	7.2^{b}	13.5^{a}	8.0^{b}	7.2^{b}	11.5^{a}	6.8^{b}	7.2^{a}	9.6^{a}	7.5^{a}	7.2^{b}	12.9^{a}	8.6^{b}
	MDB	9.0^{a}	6.0^{a}	8.3^{a}	9.0^{a}	10.0^{a}	8.3^{a}	9.0^{a}	8.4^{a}	10.3^{a}	9.0^{a}	8.6^{a}	9.8^{a}	9.0^{a}	8.0^{a}	10.6^{a}
	ALB	41.2^{b}	43.5^{b}	52.2^{a}	41.2^{a}	44.7^{a}	47.4^{a}	41.2^{b}	47.1^{a}	48.9^{a}	41.2^{c}	49.0^{b}	56.2^{a}	41.2^{c}	48.2^{b}	54.2^{a}
	CFB	48.3^{a}	46.0^{a}	48.4^{a}	48.3^{a}	44.1^{a}	44.1^{a}	48.3^{a}	48.0^{a}	47.1^{a}	48.3^{a}	47.5^{a}	50.6^{a}	48.3^{a}	47.5^{a}	51.1^{a}
T_{dur}	CCB	41.9^{a}	45.8^{a}	51.6^{a}	41.9^{a}	43.0^{a}	49.6^{a}	41.9^{a}	49.6^{a}	47.7^{a}	41.9^{a}	46.9^{a}	45.6^{a}	41.9^{a}	48.6^{a}	48.7^{a}
	GPB	42.0^{b}	51.5^{a}	51.5^{a}	42.0^{b}	47.9^{a}	49.3^{a}	42.0^{b}	51.0^{a}	53.5^{a}	42.0^{b}	53.5^{a}	54.3^{a}	42.0^{b}	52.3^{a}	52.7^{a}
	MDB	47.5^{b}	52.5^{ab}	54.8^{a}	47.5^{a}	41.6^{b}	48.1^{a}	47.5^{a}	51.8^{a}	50.1^{a}	47.5^{b}	52.0^{a}	53.3^{a}	47.5^{c}	54.2^{b}	58.0^{a}

[§] Means with the same letters in a row of each sub-table, (a), (b), (c), (d), and (e), are not significantly different at $p < 0.05$ ($n = 11$).

[†] I_{int}, initial intensity; I_{max}, maximum intensity; T_{max}, time to maximum intensity; T_{dur}, duration time; ALB, alcohol bitterness; CFB, coffee bitterness; CCB, cocoa bitterness; GPB, grapefruit pith bitterness; MDB, medicinal bitterness.

[¶] I_{int} and I_{max} ranged from 0 to 10 cm and T_{max} and T_{dur} measured in sec.

Table 6.7. Correlation between 18 significant time-intensity parameters for the five bitterness attributes of 13 samples solutions

TI		I_{int}[§]					I_{max}					T_{max}			T_{dur}				
parameters		ALB	CFB	CCB	GPB	MD	ALB	CFB	CCB	GPB	MD	ALB	CCB	GPB	AL	CFB	CC	GP	MD
I_{int}	ALB	**1.00**[†]																	
	CFB	**0.75**	**1.00**																
	CCB	0.45	0.17	**1.00**															
	GPB	**0.56**	0.37	**0.71**	**1.00**														
	MD	0.41	0.08	0.33	0.24	**1.00**													
I_{max}	ALB	**0.83**	0.54	0.51	**0.57**	**0.69**	**1.00**												
	CFB	**0.87**	0.55	**0.62**	**0.68**	**0.59**	**0.95**	**1.00**											
	CCB	**0.78**	0.46	0.50	**0.65**	**0.73**	**0.91**	**0.91**	**1.00**										
	GPB	**0.83**	0.50	**0.60**	**0.75**	**0.71**	**0.94**	**0.95**	**0.96**	**1.00**									
	MD	**0.86**	0.52	0.52	**0.65**	**0.72**	**0.96**	**0.96**	**0.96**	**0.98**	**1.00**								
T_{max}	ALB	0.38	0.46	-0.34	0.03	0.41	0.45	0.30	0.37	0.37	0.46	**1.00**							
	CCB	0.33	0.02	-0.04	0.06	0.17	0.23	0.11	0.14	0.17	0.24	0.31	**1.00**						
	GPB	-0.22	-0.33	0.39	0.16	0.14	-0.20	-0.17	-0.03	-0.05	-0.15	-0.41	-0.24	**1.00**					
T_{dur}	ALB	**0.76**	0.51	**0.64**	**0.77**	**0.64**	**0.90**	**0.92**	**0.85**	**0.94**	**0.90**	0.26	0.16	-0.13	**1.00**				
	CFB	**0.71**	0.47	**0.57**	**0.65**	0.52	**0.89**	**0.91**	**0.85**	**0.89**	**0.88**	0.30	0.01	-0.28	**0.85**	**1.00**			
	CCB	**0.76**	0.44	0.39	0.41	**0.88**	**0.87**	**0.80**	**0.88**	**0.89**	**0.91**	0.53	0.31	-0.05	**0.78**	**0.72**	**1.00**		
	GPB	**0.79**	**0.56**	0.52	**0.76**	**0.61**	**0.77**	**0.83**	**0.82**	**0.91**	**0.88**	0.39	0.12	-0.09	**0.88**	**0.75**	**0.81**	**1.00**	
	MD	**0.82**	0.43	**0.57**	**0.59**	**0.64**	**0.89**	0.95	**0.91**	**0.93**	**0.92**	0.19	0.07	-0.15	**0.86**	**0.89**	**0.83**	**0.82**	**1.00**

[§] I_{int}, initial intensity; I_{max}, maximum intensity; T_{max}, time to maximum intensity; T_{dur}, duration time; ALB, alcohol bitterness; CFB, coffee bitterness; CCB, cocoa bitterness; GPB, grapefruit pith bitterness; MDB, medicinal bitterness.
[†] The bolded values are significant at $p < 0.05$.

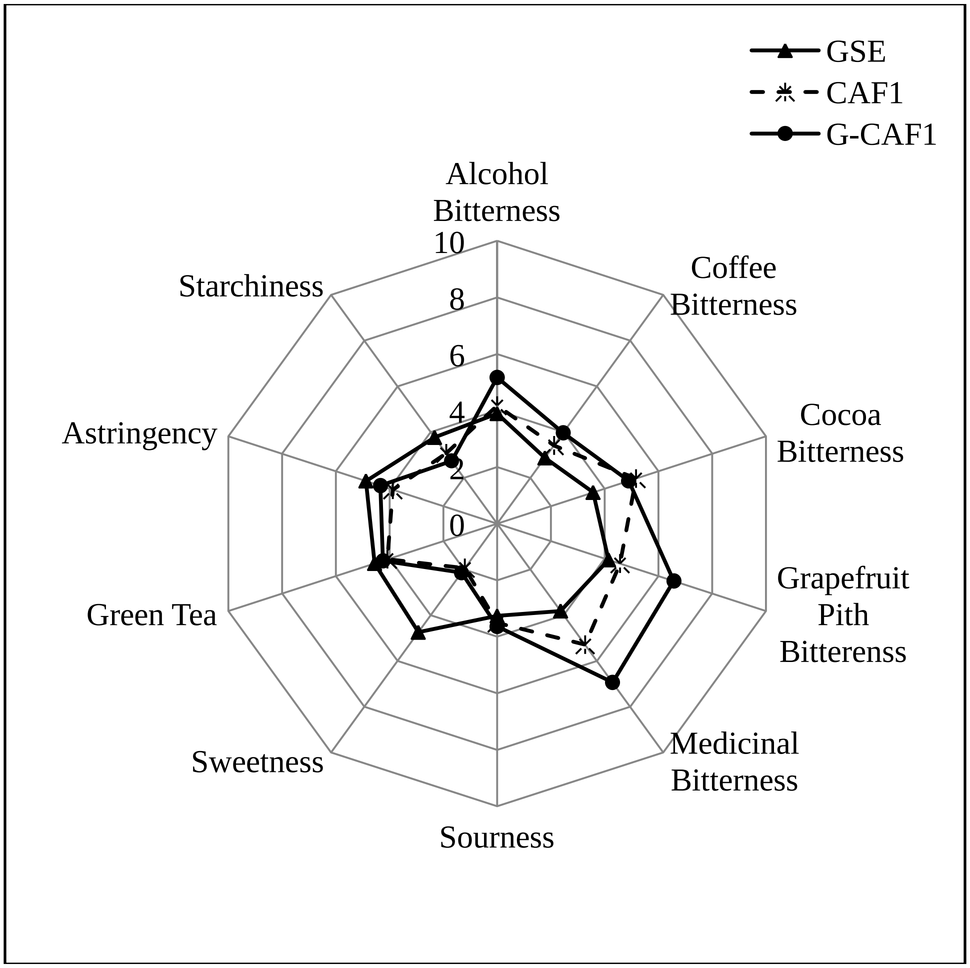

Figure 6.1. A spider web graph of sensory profile of 0.010 g of ginseng extract/100 mL of water (GSE), 0.100 g of caffeine/100 mL of water (CAF1), and CAF1 with 0.010 g of ginseng extract (G-CAF1).

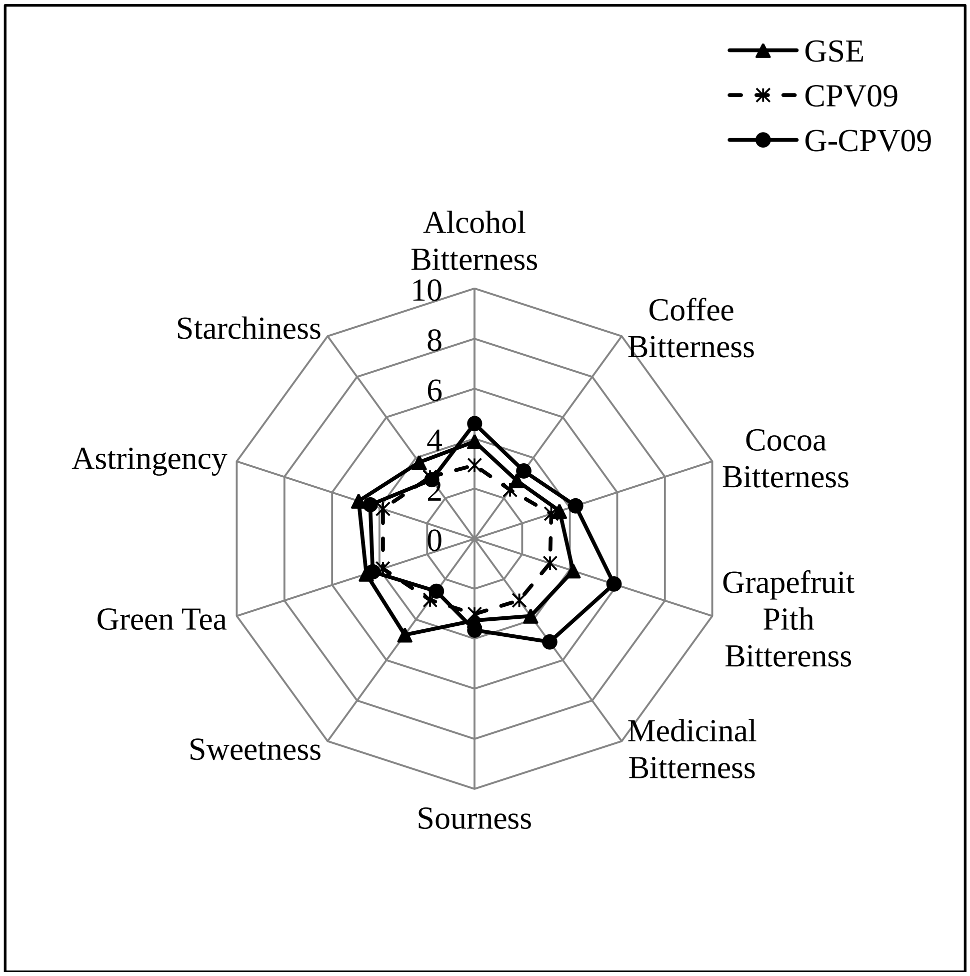

Figure 6.2. A spider web graph of sensory profile of 0.010 g of ginseng extract/100 mL of water (GSE), 0.090 g of cyclo (L-Pro-L-Val)/100 mL of water (CPV09), and CPV09 with 0.010 g of ginseng extract (G-CPV09).

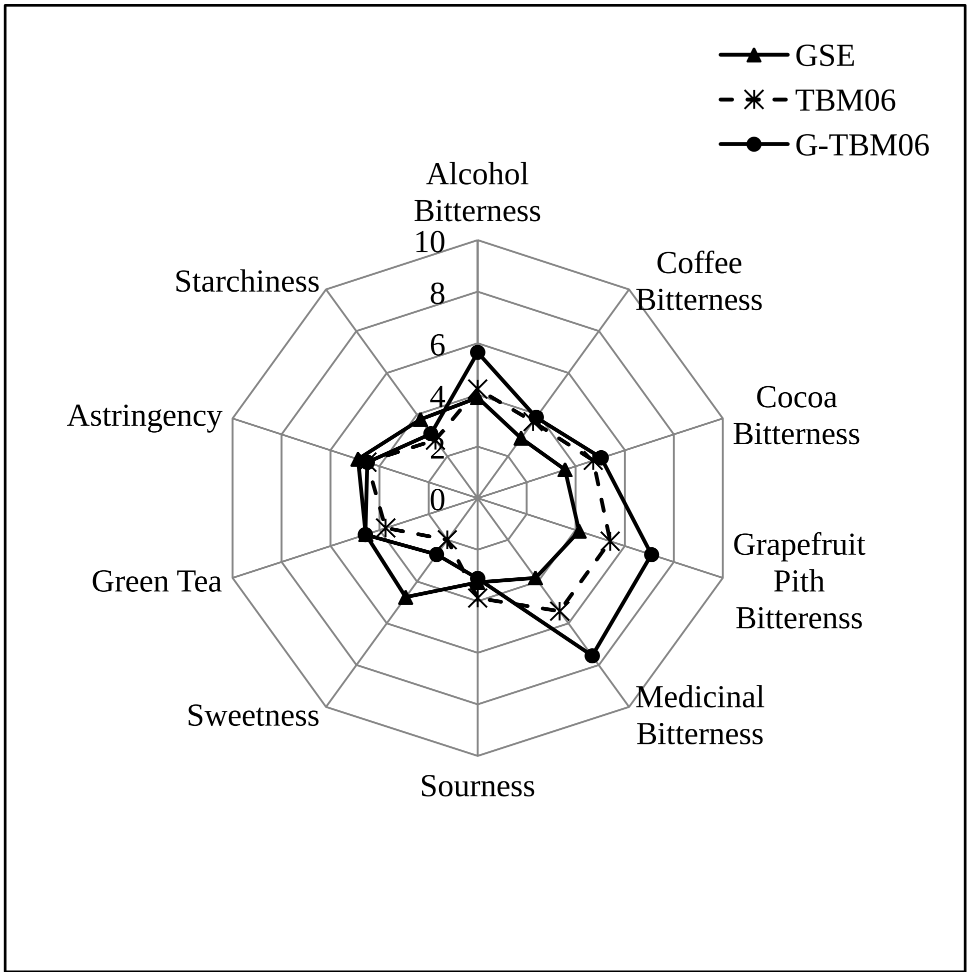

Figure 6.3. A spider web graph of sensory profile of 0.010 g of ginseng extract/100 mL of water (GSE), 0.060 g of theobromine/100 mL of water (TBM06), and TBM06 with 0.010 g of ginseng extract (G-TBM06).

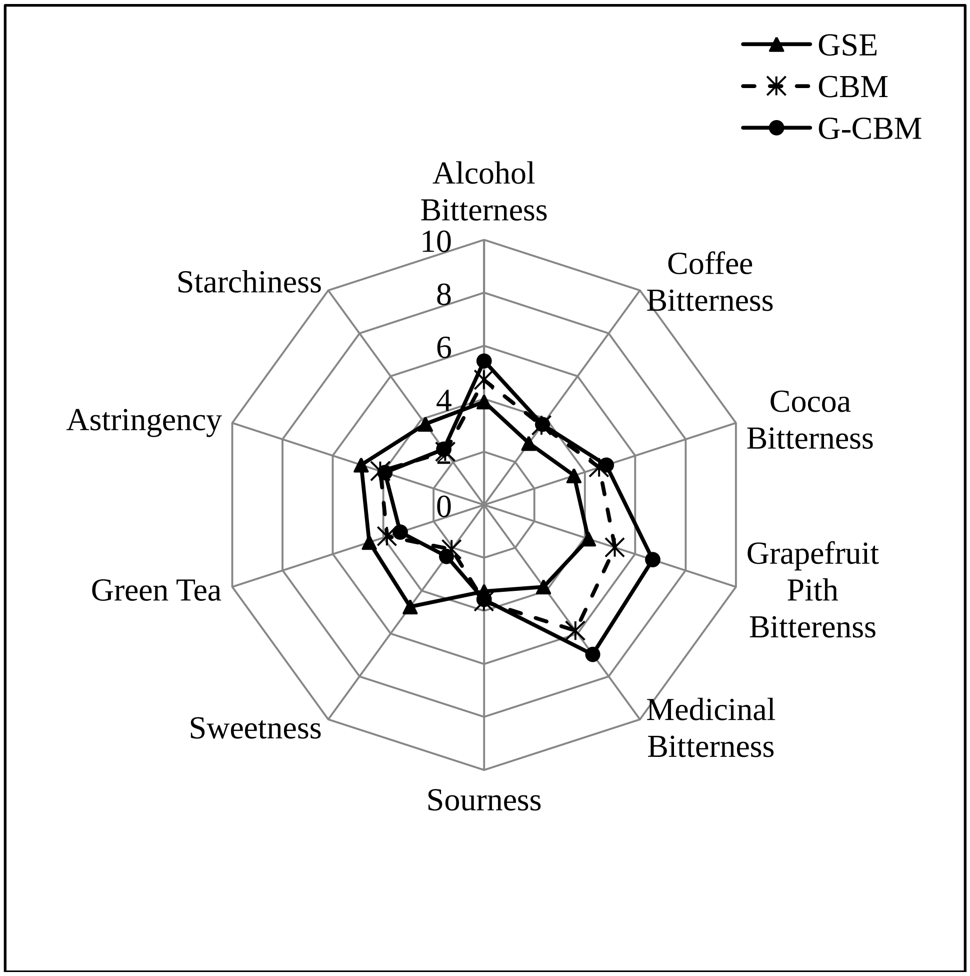

Figure 6.4. A spider web graph of sensory profile of 0.010 g of ginseng extract/100 mL of water (GSE), a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (CBM), and CBM with 0.010 g of ginseng extract (G-CBM).

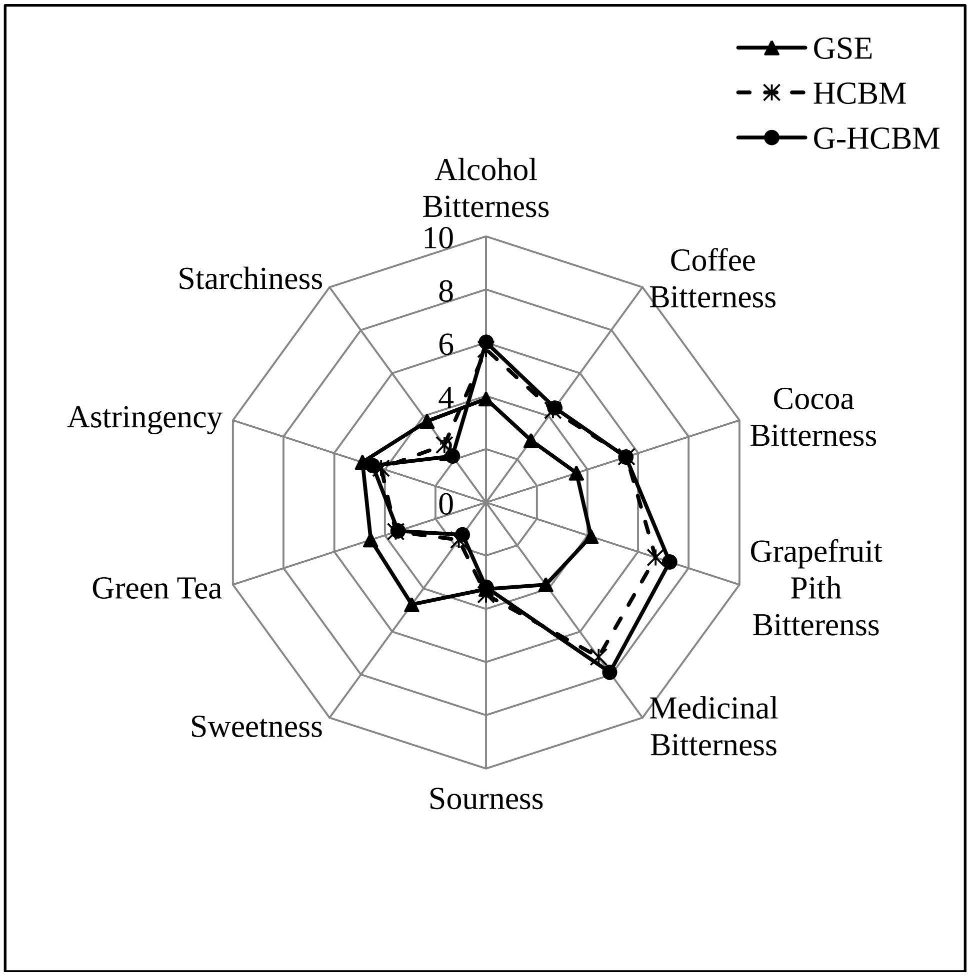

Figure 6.5. A spider web graph of sensory profile of 0.010 g of ginseng extract/100 mL of water (GSE), a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL (HCBM), and HCBM with 0.010 g of ginseng extract (G-HCBM).

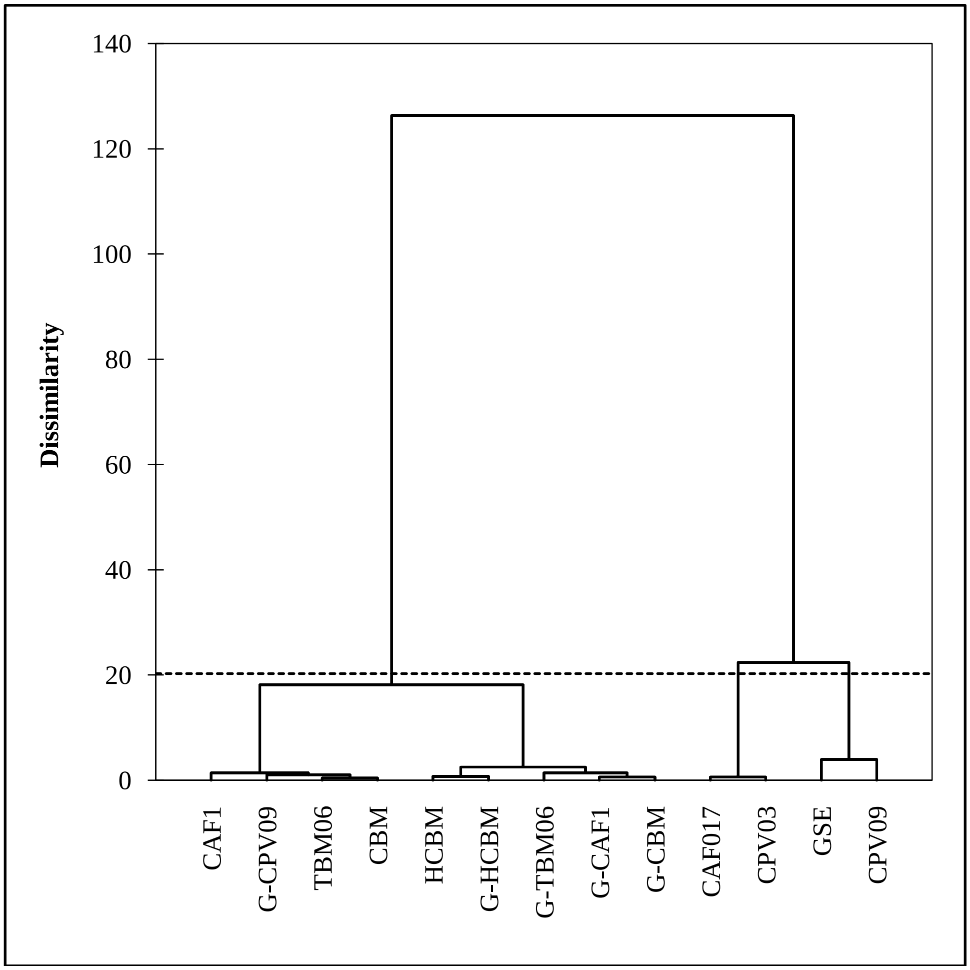

Figure 6.6. Agglomerative hierarchical clustering of 13 solutions by intensity ratings for 10 attributes on the dissimilarity scale by Euclidean distance and agglomeration by the Ward's method. The dotted line on the dendrogram is located at the node before the largest relative increase in dissimilarity level.
GSE, 0.010 g of ginseng extract/100 mL; CAF1, 0.100 g of caffeine/100 mL; G-CAF1, CAF1 with 0.010 g of ginseng extract; CPV09, 0.090 g of cyclo (L-Pro-L-Val)/100 mL; G-CPV09, CPV09 with 0.010 g of ginseng extract; TBM06, 0.060 g of theobromine/100 mL; G-TBM06, TBM06 with 0.010 g of ginseng extract; CBM, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-CBM, CBM with 0.010 g of ginseng extract; HCBM, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-HCBM, HCBM with 0.010 g of ginseng extract.

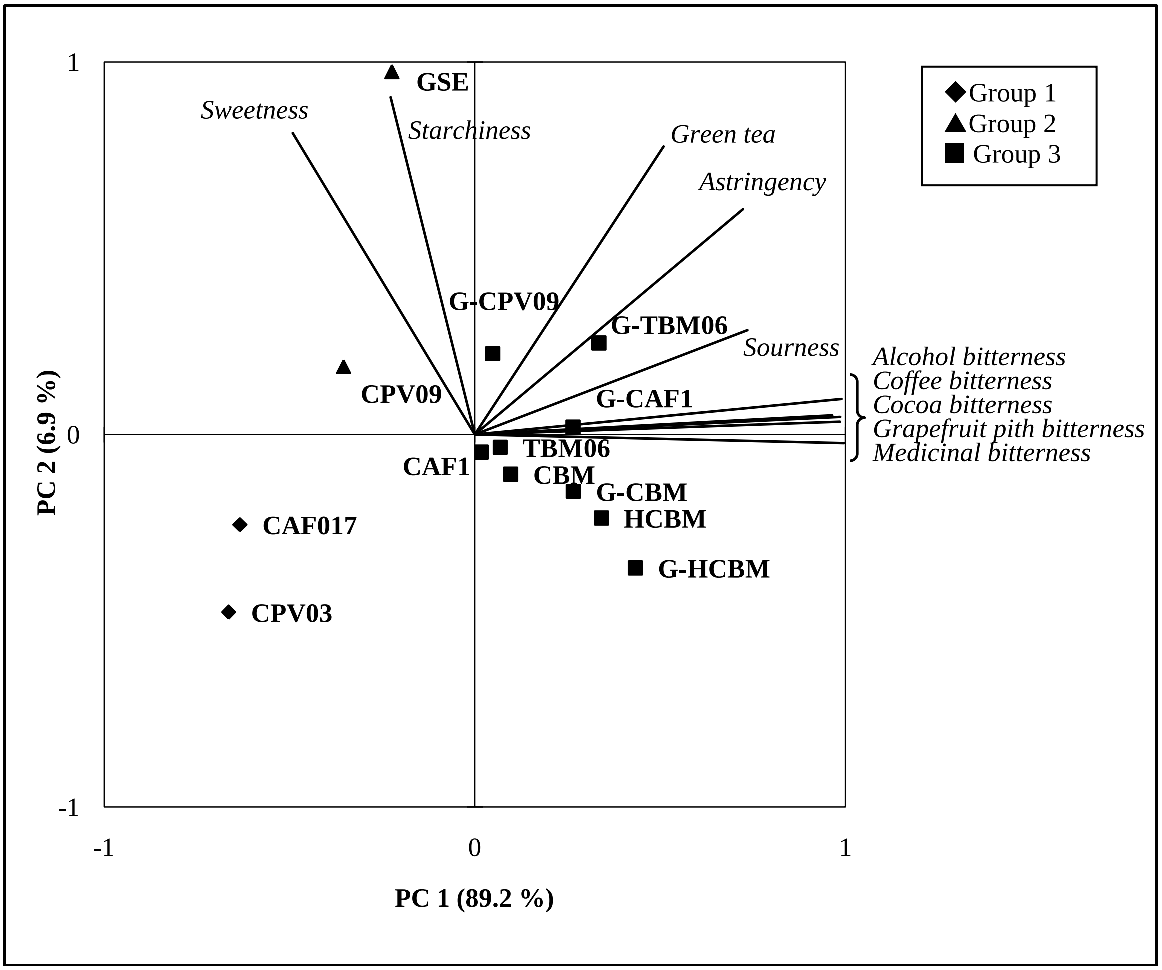

Figure 6.7. Principal component analysis biplot of principal component 1 and 2 by the covariance matrix of the mean intensity ratings for 10 attributes across 13 solutions. The biplot was rotated with the varimax method.

GSE, 0.010 g of ginseng extract/100 mL; CAF1, 0.100 g of caffeine/100 mL; G-CAF1, CAF1 with 0.010 g of ginseng extract; CPV09, 0.090 g of cyclo (L-Pro-L-Val)/100 mL; G-CPV09, CPV09 with 0.010 g of ginseng extract; TBM06, 0.060 g of theobromine/100 mL; G-TBM06, TBM06 with 0.010 g of ginseng extract; CBM, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-CBM, CBM with 0.010 g of ginseng extract; HCBM, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-HCBM, HCBM with 0.010 g of ginseng extract**.**

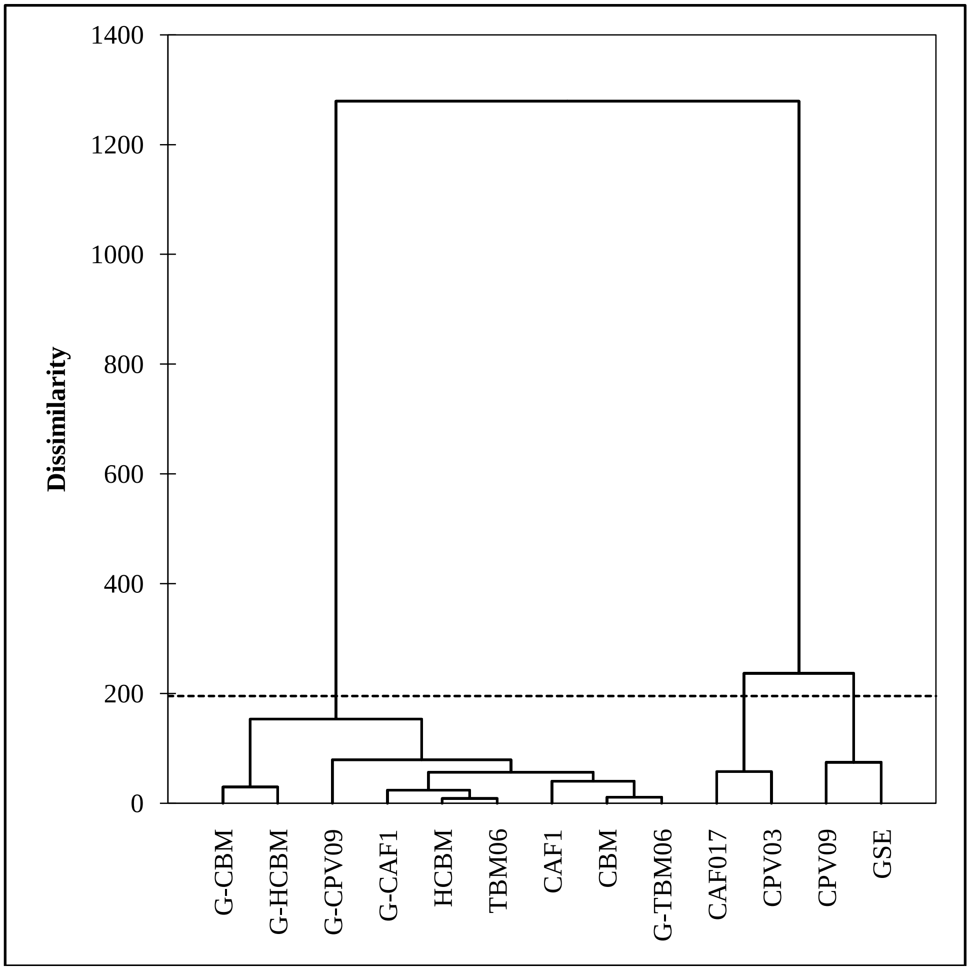

Figure 6.8. Agglomerative hierarchical clustering of 13 solutions by mean scores of 18 significant time-intensity parameters on the dissimilarity scale by Euclidean distance and agglomeration by the Ward's method. The dotted line on the dendrogram is located at the node before the largest relative increase in dissimilarity level.

GSE, 0.010 g of ginseng extract/100 mL; CAF1, 0.100 g of caffeine/100 mL; G-CAF1, CAF1 with 0.010 g of ginseng extract; CPV09, 0.090 g of cyclo (L-Pro-L-Val)/100 mL; G-CPV09, CPV09 with 0.010 g of ginseng extract; TBM06, 0.060 g of theobromine/100 mL; G-TBM06, TBM06 with 0.010 g of ginseng extract; CBM, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-CBM, CBM with 0.010 g of ginseng extract; HCBM, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-HCBM, HCBM with 0.010 g of ginseng extract.

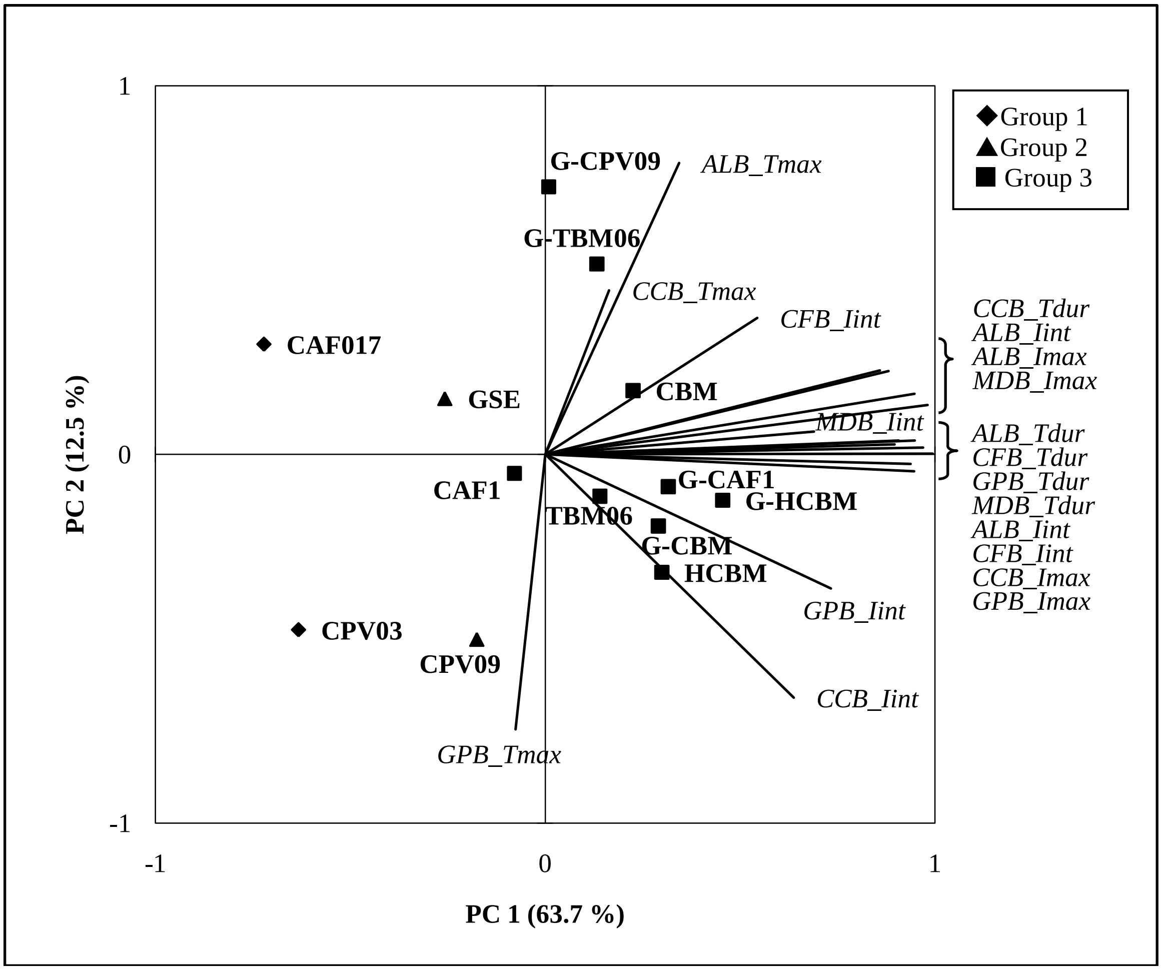

Figure 6.9. Principal component analysis biplot of principal component 1 and 2 by the correlation matrix of mean scores of 18 significant time-intensity parameters across 13 solutions. The biplot was rotated with the varimax method.
GSE, 0.010 g of ginseng extract/100 mL; CAF1, 0.100 g of caffeine/100 mL; G-CAF1, CAF1 with 0.010 g of ginseng extract; CPV09, 0.090 g of cyclo (L-Pro-L-Val)/100 mL; G-CPV09, CPV09 with 0.010 g of ginseng extract; TBM06, 0.060 g of theobromine/100 mL; G-TBM06, TBM06 with 0.010 g of ginseng extract; CBM, a milk chocolate bitterness model solution at 0.017 g of caffeine, 0.030 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-CBM, CBM with 0.010 g of ginseng extract; HCBM, a higher level of chocolate bitterness model solution at 0.100 g of caffeine, 0.090 g of cyclo (L-Pro-L-Val), and 0.060 g of theobromine/100 mL; G-HCBM, HCBM with 0.010 g of ginseng extract; ALB, alcohol bitterness; CFB, coffee bitterness; CCB, cocoa bitterness; GPB, grapefruit pith bitterness; MDB, medicinal bitterness; I_{int}, initial intensity; I_{max}, maximum intensity; T_{max}, time to maximum intensity; T_{dur}, duration time**.**

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CHAPTER 7. SUMMARY

The functional food market is growing rapidly owing to the recognition of scientifically demonstrated health benefits. In the United States, ginseng is one of the most popular herbs used for dietary supplements. However, utilization of ginseng in food products has been largely limited to beverages. This is partially attributed to the peculiar bitter tastes innate to ginseng. However, sensory properties of ginseng have not been fully researched. Furthermore, consumer sensory research on ginseng and related food products has not been conducted in the United States. Therefore, this present research was designed to probe U.S. consumers' insights into and acceptance of ginseng food products and to characterize the sensory properties of ginseng.

A focus group study found that panelists had experienced limited types of ginseng products, such as energy drinks and teas. The popularity of the product brand and information on packaging were the factors that influenced panelists' intent to purchase ginseng food products. Panelists suggested that more health claims should appear on the package. Cookies, snacks, cereals, energy bars, chocolates, and coffee were proposed as base food systems that ginseng could be incorporated into. Commercial Korean red ginseng root slices preserved with honey were the least acceptable to panelists due to the strange product type and the strong stickiness in texture. This indicated that unfamiliarity with ginseng would be the major obstacle to launching ginseng food products in the U.S. market. Therefore, our findings suggested that more advertising, marketing, and education would be necessary to increase awareness of the health benefits of ginseng. Bitter, earthy, musty, and molasses flavors in ginseng food products should be removed, and addition of sweeteners and fruity and spicy flavors were suggested to increase sensory acceptance. Korean red ginseng candy with vitamin C, including fruity and sweet flavors, was suggested as a good example in which ginseng bitter tastes were effectively masked.

Conjoint analysis found that consumers had a low level of initial interest in the topic of ginseng food products. "Sweetness" and "ginseng chocolate" were found as elements drawing consumers' interest. Meanwhile, "bitterness" and "earthy flavor" were considered to detract from consumers' interest. Among four categories employed in the conjoint analysis, "predominant sensory property" influenced consumers the most to purchase ginseng food products. Findings suggested that the original ginseng flavors, including bitterness and earthiness, be minimized in order to establish potential for success in the U.S. market. Conjoint analysis study also revealed that a ginseng chocolate product was expected as a potential product for success in the U.S. market.

Three independent consumer acceptance tests were conducted to examine U.S. consumers' acceptance levels of commercial Korean red ginseng products, ginseng tea with varying concentrations of two sweeteners, and ginseng chocolate with different concentrations of ginseng extract. Korean red ginseng candy with vitamin C and Korean red ginseng crunchy white chocolate were the most accepted among seven commercial Korean red ginseng products. Korean red ginseng root slices preserved with honey were the least acceptable product. These findings quantitatively corroborated the results from the preceding focus group study, including the conclusion that the ginseng candy with vitamin C would be the most acceptable to U.S. consumers, owing to the sensory attributes being improved from original ginseng tastes. Furthermore, the results from the consumer acceptance test supported the notion that a ginseng chocolate product could be successfully launched in the U.S. market. When ginseng was incorporated into a model tea system, it was found that sensory acceptance levels of ginseng tea increased in proportion to the content of sugar and honey. Aroma acceptance was rated slightly higher in ginseng tea with honey than ginseng tea with sugar. These findings agreed with the results from the previous focus group study, including which sweeteners would improve sensory acceptance of ginseng food products, and that consumers might prefer honey to sugar as a sweetener. On the other hand, increasing levels of ginseng extract decreased sensory acceptance levels of ginseng milk and dark chocolates. Consumers preferred ginseng milk chocolate to ginseng dark chocolate at the same levels of added ginseng extract, which was presumably due to the higher level of sweetness in milk chocolate.

A descriptive analysis, including a time-intensity (TI) rating, profiled sensory characteristics of ginseng extract, caffeine, cyclo (L-Pro-L-Val), theobromine, and two model solutions simulating chocolate bitterness, and examined the changes in the sensory characteristics of those compounds by the addition of ginseng extract. Alcohol bitterness, coffee bitterness, cocoa bitterness, grapefruit pith bitterness, medicinal bitterness, sweetness, sourness, green tea, astringency, and starchiness were the attributes significantly different across sample solutions. Ginseng extract was characterized to have more sweetness, starchiness, and green tea than the other samples. The addition of ginseng extract modified sensory profile of caffeine (0.100 g/100 mL), cyclo (L-Pro-L-Val) (0.090 g/100 mL), and theobromine solutions, and a model solution (CBM), which simulates milk chocolate bitterness, as increasing alcohol bitterness, grapefruit pith bitterness, and medicinal bitterness of those solutions. Moreover, the addition of ginseng extract increased only the medicinal bitterness of the dark chocolate bitterness model solution (HCBM), which included more caffeine and cyclo (L-Pro-L-Val) than CBM. The distinctive tastes of ginseng extract, including sweetness, starchiness, and green tea, were effectively masked when the extract was mixed with caffeine (0.100 g/100 mL), cyclo (L-Pro-L-Val) (0.090 g/100 mL), CBM, and HCBM. Findings illustrated that peculiar tastes innate to ginseng could be partially masked by bitterness in coffee and chocolate, and dark chocolate would be a more effective medium than milk chocolate with which mask ginseng tastes. The addition of ginseng extract increased intensity-related TI parameters of caffeine (0.100 g/100 mL) and cyclo (L-Pro-L-Val) (0.090 g/100 mL), which were relatively lower in concentration levels than two model solutions, and time-related TI parameters of two model solutions, which were relatively higher in concentration levels among solutions examined in this study. This demonstrated that the bitterness in chocolate with ginseng extract may last longer than in chocolate without ginseng extract.

In conclusion, dark chocolate containing ginseng can be proposed as a new ginseng food product that will have potential for success in the U.S. market. Alternatively, ginseng food products predominant in sweet and fruity flavors are expected to draw consumers' interest. In addition to improvement in sensory properties, more advertising, marketing, education, and informative packaging are necessary to increase U.S. consumers' familiarity with ginseng. Future research may include a descriptive analysis with ginseng food products to identify the key drivers of liking and disliking for successful new product development. Moreover, the question of whether aroma compounds found in coffee and chocolate might influence the perception of ginseng tastes could warrant further investigation.

APPENDIX A. PRE-SCREENING QUESTIONNAIRE FOR GINSENG FOCUS GROUP

Recruitment Questions for Focus Group Research on Ginseng Food Products

Thank you for your interest in a ginseng product focus group! This focus group was designed to assess U.S. consumers' awareness of ginseng food products and to develop new food products toward the U.S. market. Prior to the focus group, I'd like to ask you some questions. Your answers on the questions will be confidential and used only for organizing the focus group study. If you have any questions and concerns on the questions, feel free to contact Hee Sook Chung at uiuc.sensory.ginseng@gmail.com. Please complete this form and send to Hee Sook Chung by email.

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1. **Are you interested in participating a focus group on ginseng food products?**
   ☐ YES ☐ NO

2. **What is your date of birth (mm/dd/yy)? ______________**

3. **What is your gender?** ☐ MALE ☐ FEMALE

4. **Are you allergic to any foods?** ☐ YES ☐ NO
   (Must not be allergic to ginseng, honey, sugar, and salt)

   If yes, please list the foods you're allergic to:

   ____

5. **Have you consumed ginseng food products before?** ☐ YES ☐ NO

   If yes, please list the foods you've consumed before:

   ____

6. **Where were you born?** ☐ In the United State ☐ In other country: __________

7. **How long have you lived in the U.S? _____** Years

8. **You are a(n)**
   ☐ African-American
   ☐ Asian
   ☐ Caucasian
   ☐ Hispanic
   ☐ Native American
   ☐ Other: ______________

Thank you for your answers! I will contact you as soon as possible.

APPENDIX B. INFORMED CONSENT FORM FOR SENSORY EVALUATION PANELISTS

INFORMED CONSENT FORM FOR SENSORY EVALUATION PANELISTS
"FOCUS GROUP RESEARCH ON GINSENG FOOD PRODUCTS"

You are invited to participate in a study involving discussion and evaluation of ginseng food products. The goal of this research is to investigate consumer awareness of and attitudes on ginseng food products and the foods' market potential in the U.S. market. You will be a in a group of 5 to 10 people discussing a food-related topic. There are no right or wrong answers. There are no risks to you beyond those of everyday life. Known allergies involved with the product in this study are ginseng, honey, sugar, and salt. If you are allergic to ginseng, honey, sugar, and salt, you should not participate in this study. You are free to withdraw from the study at any time for any reason. We also reserve the right to terminate your participation at any time for any reason, including arriving late or inability to follow directions. The decision to participate, decline, or withdraw from participation will have no effect on your status at or future relations with the University of Illinois.

The study will be conducted at Bevier Hall Room # 376 (Sensory lab). We anticipate that the time needed on your part for a complete run of the experiment to be 1 to 1.5 hours. Participation in the study will be voluntary, and you will be compensated $10 for your participation.

Responses collected from the focus group are coded and codes are not linked to the panelists' names. Results from this research will be disseminated in the form of thesis paper, journal article, and conference presentation. However, any publications or presentations of the results of the research will only include information about group performance. However, the researchers cannot guarantee that the other participants will not share responses outside the session.

Benefits of this research to society will be a good understanding towards U.S. consumer awareness of and attitudes on ginseng food products. Panelists will gain experience in product evaluation, concept evaluation, and focus group research.

You are encouraged to ask any questions that you might have about this study whether before, during, or after your participation. However, specific questions about the samples that could influence the outcome of the study will be deferred to the end of the experiment. Concerns or questions can be addressed to Dr. Soo-Yeun Lee (217-244-9435, soolee@illinois.edu) or Hee Sook Chung (217-244-6304, chung22@illinois.edu). You may also contact the IRB Office (217-333-2670, irb@illinois.edu) for any question about the rights of research subjects. If you live outside the local calling area, you may also call collect.

____I agree that the researchers use BOTH audio and video recording during my session.

By signing below, I certify that I am at least 18 years in age and I understand the information and voluntarily consent to participate in the study described above. I have been given a copy of this consent form.

Signature ______________________________ Date ______________

Printed Name ______________________________